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Demonstration Physical Chemical Sewage Treatment Plant Utilizing Biological Nitrification

Sanitation District No. 1 of Campbell and Kenton Counties, Covington, KY

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DEMONSTRATION PHYSICAL CHEMICAL SEWAGE TREATMENT PLANT UTILIZING BIOLOGICAL NITRIFICATION

by

E. Brenton Henson

Sanitation District No. 1 of
Campbell & Kenton Counties, Ky.
Covington, Kentucky 41011

Grant No. S802719

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16. ABSTRACT

This demonstration project in a small residential community in Kentucky was initiated to show the feasibility of treating sewage with a physical-chemical type of wastewater treatment plant with a biological process for nitrification.

The 50,000 gallon per day system had unit processes consisting of screening, flow equalization, chemical clarification using lime, biological nitrification, filtration, and activated carbon adsorbtion.

A significant feature of the demonstration was the reliability with which a high quality effluent could be produced in spite of the numerous equipment and operational problems encountered. Plant removal efficiency, as measured by the removal of BOD_5 and suspended solids was 93 and 97 per-cent, respectively. Phosphorous levels were reduced by more than 80 per-cent during the chemical clarification step. Total nitrogen concentration was reduced by up to one-third during the treatment. Effluent BOD_5 and suspended solids levels were significantly lower for this process than the average values obtained from seven various types of biological treatment plants.

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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research; a most vital communication link between the researcher and the user community.

The study summarized in this report demonstrates that very high levels of treatment can be achieved using a physical-chemical type of wastewater treatment plant utilizing a modular design and high rate processes. In addition the system demonstrates exceptional reliability in achieving high treatment efficiency.

Francis T. Mayo, Director
Municipal Environmental Research Laboratory

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ABSTRACT

This demonstration project was initiated to show the feasibility of treating sewage utilizing a physical-chemical type wastewater treatment plant in combination with a biological process for oxidation of nitrogenous material.

The project involved the design, fabrication, installation, operation, and evaluation of a 50,000 gallons per day wastewater treatment system serving a small residential community in Southern Kenton County, Kentucky. The unit processes consisted of screening, flow equalization, chemical clarification using lime, biological nitrification, filtration, and activated carbon adsorption. The biological nitrification step was included to convert those nitrogen forms, which in the effluent flows exert an oxygen demand on the receiving stream, to the nitrite and nitrate forms.

The test data shows the demonstration plant was able to consistently produce a very high quality effluent. Effluent BOD_5 (biochemical oxygen demand), COD (chemical oxygen demand) and suspended solids results from the demonstration plant were compared to the average values obtained from seven various types of biological treatment systems. In all cases, the demonstration plant showed significantly lower values. Plant removal efficiency, as measured by BOD_5 and suspended solids, was an excellent 93% and 97%, respectively. Phosphorus levels were reduced in excess of 80% during passage through the treatment process, with the chemical clarification process providing the only significant reduction. Total nitrogen levels were reduced by about one-third during treatment.

A significant feature of the demonstration plant was the reliability with which a high quality effluent could be produced. This is especially significant in view of the numerous equipment and operational problems encountered

This report was submitted in fulfillment of EPA Grant No. S-802719, by the Sanitation District No. 1 of Campbell and Kenton Counties, Kentucky under the sponsorship of the U. S. Environmental Protection Agency and the U.S. Department of Housing and Urban Development.

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METRIC CONVERSIONS

TO CONVERT FROM	TO	MULTIPLY BY
feet	meters	0.3048
ft^2	m^2	0.0929
ft^2/ft^3	m^2/m^3	3.281
gal/day/ft	m^3/day/m	1.241×10^{-2}
gal/day/ft^2	m^3/day/m^2	4.074×10^{-2}
gallons	liters	3.785
gallons	m^3	3.785×10^{-3}
gal/min/ft^2	liter/min/m^2	40.74
horsepower	kilowatt	0.7457
inch	cm	2.54
lb/ft^3	kg/m^3	16.02
pound	kilogram	0.4536

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SECTION 1

INTRODUCTION

In recent years a significant segment of the population has become aware and concerned with the limited ability of our environment to absorb the by-products of increased population and prosperity. The results of this concern are evident from the profusion of new laws and greatly increased expenditures at all levels of government related to environmental areas. Stream degradation, obvious from a visual standpoint as well as its impact on our daily lives, has served as a primary target for our national effort. The efforts to date have been obvious and encouraging, especially those efforts involving sewage treatment prior to stream discharge.

As we review the results to date and attempt to refine our sewage treatment needs and capabilities, several areas of concern are evident. Primary among the goals of sewage treatment has been the reduction of organic material in the form of biochemical oxygen demand (BOD) and suspended solids. The discharge of organic material in excess of a streams natural ability to assimilate results in a depleted oxygen supply, causing septic conditions in which normal stream life is unable to survive. Sewage treatment plant effluent flows may also contain significant quantities of oxygen demanding material other than organic matter. Research has clearly shown that nitrogenous material can be present in sufficient quantities to severely affect the dissolved oxygen content of receiving waters. Treatment plants designed for substantial removal of suspended solids and biochemical oxygen demand may remove insignificant amounts of nitrogenous matter, even during proper operation.

Experience also shows the need for flexible and efficient sewage treatment units that are able to meet the even more stringent regulations imposed by governmental units. Urban fringe developments are particular problem areas that outstrip the service ability of urban sewage authorities.

Small housing, commercial and public developments spring up beyond the range of central sewage transport systems and must be provided acceptable sewage treatment until such time as interceptor lines are extended to the area. The often temporary nature of the treatment facilities also compounds the problem, resulting in heavy capital equipment outlays prorated over

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relatively short time periods. The small size and nature of such development areas frequently provide flow variations that are not conductive to effective biological treatment. Daily, as well as seasonal fluctuations may be extreme in both hydraulic and organic loadings. The need for treatment processes that can be placed in service quickly and meet strict effluent limitations is obvious. Development areas on urban fringes frequently discharge to small streams with either little dry weather flow or periodic high rainy weather flow. Effluent limitations are generally based on the most extreme low flow conditions.

This demonstration project was conducted to show the feasibility of treating sewage utilizing a wastewater treatment plant of the physical-chemical type employing a biological process for oxidation of nitrogenous material. The plant employed was of a modular design employing high-rate processes, allowing ease of transport for relocation of the plant to other critical areas when needed and relatively speedy installation and placement in service with a minimum of set-up time. The project was originally designed to demonstrate that the plant could produce a high quality effluent and provide different treatment levels to meet different effluent requirements.

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SECTION 2

CONCLUSIONS

The results show that a very high level of treatment can be achieved utilizing a treatment system of the physical-chemical type as employed for the demonstration project. Removals over the entire period of operation averaged 93% for BOD_5 and 97% for suspended solids, with other measures of organic removal also showing excellent reductions. Phosphorus removals, as measured by acid-hydrolyzable and orthophosphate, were in excess of 80%. The degree of treatment from the demonstration plant was evaluated in comparison to seven different types of biological treatment units. In all seven comparisons, the demonstration plant produced a superior effluent.

An evaluation of factors affecting conversion of organic and ammonia nitrogen forms to the nitrite and nitrate forms indicate that recirculation was necessary to achieve satisfactory levels of nitrification in this study. The hydraulic loading rate of 0.4 gallons per minute per square foot was apparently not adequate. Higher application rates can be achieved by either smaller sizing of the nitrification unit or recirculation of the effluent flow. Application rates of 0.5 - 1.0 gallons per minute per square foot are indicated. Recirculation ratios in the range of 1:1 are considered adequate.

Activated carbon replacement was not found to be necessary during the period of plant operation. Previous studies had indicated extended activated carbon adsorber life was possible when influent flows contained nitrates. Although nitrate levels into the adsorbers were not as high as expected, no exhaustion of the carbon was evident at project termination. In addition, nitrate concentrations were of sufficient concentration to prevent the development of hydrogen sulfide odors within the activated carbon adsorbers.

The reliability with which the demonstration plant was able to achieve the high levels of treatment was notable. Equipment and operational problems were severe on occasion, but the design of the system allowed for continued high levels of treatment prior to discharge. Comparison of effluent data from the demonstration plant with data from other biological type treatment units showed the demonstration plant exhibited superior reliability in producing a high quality effluent.

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SECTION 3

RECOMMENDATIONS

The type of treatment system employed for the demonstration project produced a high quality effluent with superior reliability and further investigation employing similar treatment units is worthy of consideration. The further evaluation of nitrification employing the fixed plastic media is especially in need of additional investigation. Proper design with additional flexibility for recirculation and variable loading rates should enable nitrification to be achieved with regularity and predictability. Additional evaluation of the ability of a nitrified waste stream to extend the life span of activated carbon is warranted. The duration of the operational phase of the project did not allow a severe testing of this phenomena. This treatment sequence would allow considerable cost reduction by eliminating frequent purchase or regeneration expense involved with activated carbon.

Several design problems developed during the operational phase of the project that necessitated either changes in design or modified operational procedures. The addition of a more efficient screening mechanism to prevent the introduction of excessive solids into the system is recommended. Excessive solids caused numerous problems prior to their removal in the lime clarification unit. The use of a diaphragm-type metering pump for feeding the lime slurry to the flash mix tank did not allow for sufficient uniformity of flow or provide the dependability of operation required. The original design employed for acid neutralization of the high pH clarifier effluent proved to be unworkable. The 50-gallon flash mix tank used for neutralization also served as a pH sensing chamber and surge tank for a downstream pump. These functions need to be separated. Also, the off-on acid metering pump employed should function on a proportional basis. This change could possibly have allowed the neutralization system to function as originally designed. The sludge storage tank consisted of a relatively flat bottom tank with stiffening ribs located within the tank. This design did not prevent the settling and compaction of the lime settled sludge from the clarifier. The density and weight of the lime sludge requires a tank configuration of different design, such as a hopper, and sufficient aeration to prevent deposition.

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SECTION 4

MATERIALS AND METHODS

STUDY LOCATION

The study location of this research project was the southern portion of Kenton County, Kentucky near the junction of Bristow Road and Richardson Road. The plant was placed within the drainage area of a planned unit development known as Beechgrove Village. The planned unit development was begun in the early 1970's as a mixture of residential homes, apartments and condominimums and has continued to develop during the entire duration of the demonstration project. This development provided the bulk of the flow for the demonstration plant. The only other source of sewage flow was an elementary school, which contributed flow to the plant beginning the latter part of August, 1978. No sewage flow of a commercial or industrial nature was involved.

FACILITIES

The pilot plant consisted of a complete wastewater treatment system. The basic design incorporated a physical-chemical treatment unit with an intermediate biological nitrification process employed to reduce oxygen demand on the receiving stream and to lengthen the service life of the granular activated carbon columns. Sizing of the plant components was based on a flow capacity of 50,000 gallons per day.

The original intent was to design the system so that all components could be mounted on a single truck for ease of transportation and relocation if desired. The entire system was designed for above ground installation. These design arrangements also allowed for installation time to be reduced to a minimum. However, spacing limitations and size restrictions for truck shipments over roadways made this impractical and necessitated the removal of the biological nitrification unit from the skid concept.

The treatment process sequence consisted of screening, flow equalization, chemical flash mix, flocculation, clarification, pH control, biological nitrification, filtration, granular activated carbon adsorption and chlorination. Sludge

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storage facilities were also incorporated into the design. A treatment process flow schematic of the demonstration plant is shown in Figure 1. The design allowed for flexibility in selecting the flow sequence involving the nitrification towers, mixed media filter, and activated carbon columns.

Influent Flow Control

Flow for the demonstration plant was taken from a manhole just upsewer from the lift station serving the Beechgrove Village development. A diversion dam within the manhole provided a flooded pipe within which was located an 8-inch air-activated pinch valve. Upon activation, the pinch valve opened and allowed diversion of the sewage to the flow equalization tank via a 2,770-feet long, 8-inch diameter gravity sewer line. Control of the pinch valve was accomplished using solid-rod liquid level electrodes located in the receiving flow equalization tank. Signals from the electrodes were transmitted via a telephone circuit to a solid-state control relay located near the pinch valve. The relay in turn controlled a 3-way solenoid valve which was installed in an air pipe between the pinch valve and air compressor unit.

This design was necessitated as the flow from the Beechgrove Village development was in excess of the design capacity of the demonstration plant. The lift station remained operational during the project and handled excess flows not required for plant operation. In addition, this arrangement provided a safety backup in the event of malfunctions or shutdowns of the demonstration plant.

Flow Equalization Tank and Screening

A bar screen with approximately one-inch openings was located at the influent part of the flow equalization tank to remove larger objects that might damage the system. The flow equalization tank consisted of a rectangular 20,000-gallon pre-fabricated steel tank. This buffer capacity allowed continuous operation during normal low flow conditions encountered at night. A diffused-air system was incorporated in the design to ensure solids suspension and mixing and to maintain aerobic conditions during storage. In addition to the influent flow control liquid-level sensors, electrodes were also installed to provide emergency shut down of the remaining treatment processes in the event of low level conditions in the flow equalization tank. Flow was pumped from the flow equalization tank to the treatment unit by a constant-speed progressive-cavity pump.

Chemical Clarification

Chemical clarification was achieved using hydrated lime fed at a constant rate in 10% slurry form. Lime slurries were made

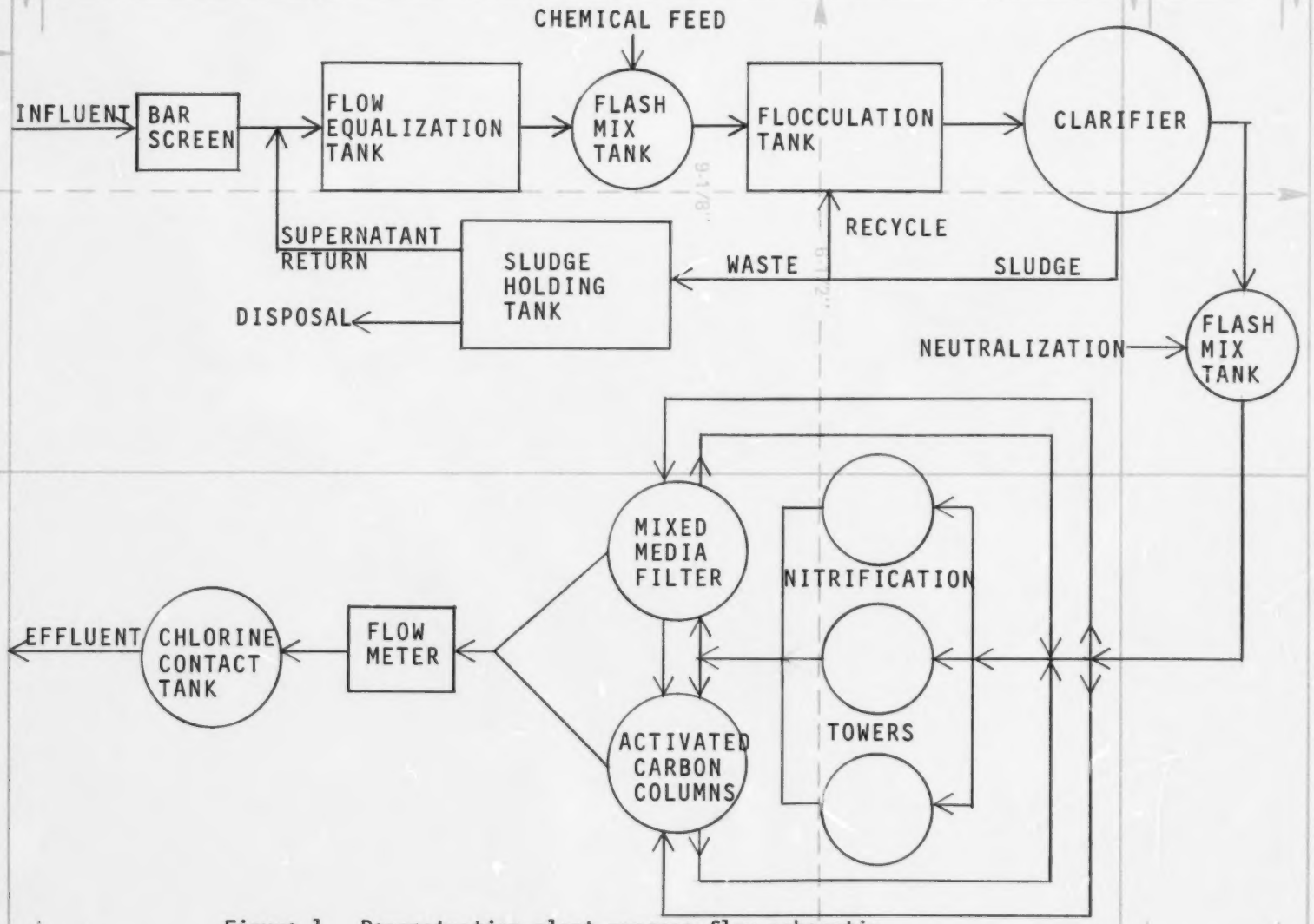

Figure 1. Demonstration plant process flow schematic.

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up on a daily basis using commercial hydrated lime in 50 lb. bags. A 360-gallon plastic tank served as the make up and storage tank. Constant mixing was required and was provided using a 1/2-H.P. constant-speed portable mixer. Lime slurries were fed to the flash mix tank using a variable speed diaphragm-type slurry metering pump. A 65-gallon bottom-feed flash mix tank and constant speed portable mixer provided a thorough mixing of the lime slurry with the incoming sewage flow. Detention time within the flash mix unit was 1.87 minutes at the design flow rate of 50,000 gallons per day.

Flocculation was provided in a square-shaped 570-gallon tank. Agitation was carefully controlled using a variable-speed, vertical-shaft portable mixer. Detention time was 16.2 minutes at design flow rate.

Flow from the flocculation tank to the circular clarifier employed a distribution box which channeled the flow to multi-outlet peripheral-feed piping near the bottom of the clarifier. The 4,710-gallon clarifier provided a 135-minute residence time at design flow rate.

The surface loading or overflow rate of the clarifier at design flow was 640 gallons per day per square foot and the weir overflow rate was 1,700 gallons per day per lineal foot. The clarifier was complete with motor-driven sludge rakes, scum skimmer and overflow circumference "V" notch weir. Sludge was gathered and raked toward the drawoff hopper by the sludge rakes. Rake speed was calculated at about 3 revolutions per hour (0.05 revolutions per minute). The hopper served as a suction reservoir for the progressive cavity sludge pump. The original plant design provided for constant sludge withdrawal, with timed options on recycle to the flocculation tank or to the sludge wasting tank. This design was later modified to allow only sludge wasting or recycle, on an intermittent basis.

pH Control

Following chemical clarification with lime, a pH reduction step was required both to prevent deposition of calcium carbonate ($CaCO_3$) in subsequent processes and to optimize the biological nitrification functions to be employed in a later process. In large-scale installations this is usually accomplished by recarbonation of high pH wastewater with CO_2. For the purposes of this system, the pH reduction was accomplished by the addition of sulfuric acid (H_2SO_4). Although the use of sulfuric acid does result in a higher calcium ion content of the waste, it represents a cost savings for this type of application.

Sulfuric acid was purchased in 13-or 15-gallon plastic carboys, and the required solution was made up daily. An 80-gallon plastic tank was used for mixing and storage of the

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20% sulfuric acid solution. A small mixer was installed to ensure the initial blending of the water and acid, as the heavier acid tends to layer at the tank bottom. A variable-speed chemical feed pump was used to transfer the solution to the 50-gallon acid flash mix tank, downstream of the clarifier. Rapid mixing of the acid feed solution and high pH clarifier effluent was provided by a portable type mixer installed in the tank. Also, the tank contained the pH electrodes for the pH measuring and control unit. The pH control unit in turn provided off-on operation of the acid feed pump. In addition to serving these functions, the acid flash mix tank also served as the surge tank for the booster pump immediately following, with the resulting pump up-pump down cycle. Needless to say, serious control problems were experienced. The design was subsequently changed to allow feeding of the acid directly into the connecting piping slightly upstream of the acid flash mix tank and the installation of a baffle within the tank to separate the mixing functions from the pH-sensing functions.

Biological Nitrification

The biological nitrification towers consisted of three separate units constructed from 72-inch diameter concrete pipe sections. Overall height of each unit was 17 feet, and they were packed to a depth of 15 feet with Filterpak® (registered trademark of Mass Transfer, Inc.) biological media. Although both natural media (gravel and coarse sand) and specially constructed plastic media have been used as the fixed growth surface, the plastic media was selected due to its structural advantages. These advantages include a high void ratio for adequate oxygen transfer and alleviation of plugging tendencies, large surface area for fixed biological growth per unit of volume and lighter weight. The physical characteristics of the plastic media used are shown in Table 1.

TABLE 1. NITRIFICATION TOWER PLASTIC MEDIA CHARACTERISTICS

Manufacturer	Mass Transfer, Inc.
Identification	YTH 1130
Specific Surface Area (random packing)	57 sq. ft./cu. ft.
Void Space	93%
Bulk Density (random packing)	4 lbs./cu.ft.

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The three nitrification units were designed for parallel operation, with adjustable flow rates to each unit. The design of the system also allowed for total recycle of "seed" sludge in order to obtain a biological population capable of effecting nitrification within a reasonable period (approximately 4 to 6 weeks) after startup. As shown in Figure 2, uniform surface distribution was accomplished using rotating distributor arms within each tower. An underdrain system for each tower discharged to a common sump for pumping to later processes. The 84.8 square feet of surface area contained in the three towers provided a loading rate of about 0.4 gallons per minute per square foot of surface area at design flow rate. The 15-foot media depth should have provided sufficient residence time. The design requirements for these parameters, as stated in Reference 1, are 0.5 - 1.0 gallon per minute per square foot and 15 feet of depth.

Depending upon the flow scheme desired, flow from the nitrification towers could be directed to the mixed media filters or the granular activated carbon towers. It was anticipated that the low net solids production associated with nitrification towers would not require intermediate clarification prior to filtration (1).

Mixed Media Filtration

The filter used was a down-flow pressure type employing two types of media. The bottom media was sand, AWWA B100 medium, 0.45 to 0.55 mm, to a depth of 12 inches. This was overlain by a 12-inch layer of anthracite, AWWA B100 No. 1, 0.6 to 0.8 mm. A 424-gallon surge tank preceded the pressure filter and provided flow storage during the filter backwash cycle. In addition, the surge tank was equipped with liquid level sensors that served as controls for the pressure filter feed pump. Flow rate through the 7.1-square foot surface area filter was controlled by a variable-orifice, pressure-compensated flow regulator at approximately 5 gallons per minute per square foot. Backwash operation was automatic with intervals between backwash cycles being operator selectable on a 24-hour time clock. Manufactures suggestion on backwash initiation was 4-5 psig pressure differential between pressure filter influent and effluent flow. This corresponds to a head loss of between 9.2 and 11.5 feet. Flexibility also existed for controlling the length of each backwash sequence. The chlorine contact tank served as the backwash source and flow was regulated through a constant-flow control valve at a rate of 17.7 gallons per minute per square foot of filter surface area. To facilitate backwash efficiency, a pre-backwash air scour was provided. Backwash water was returned to the head end of the flow equalization tank.

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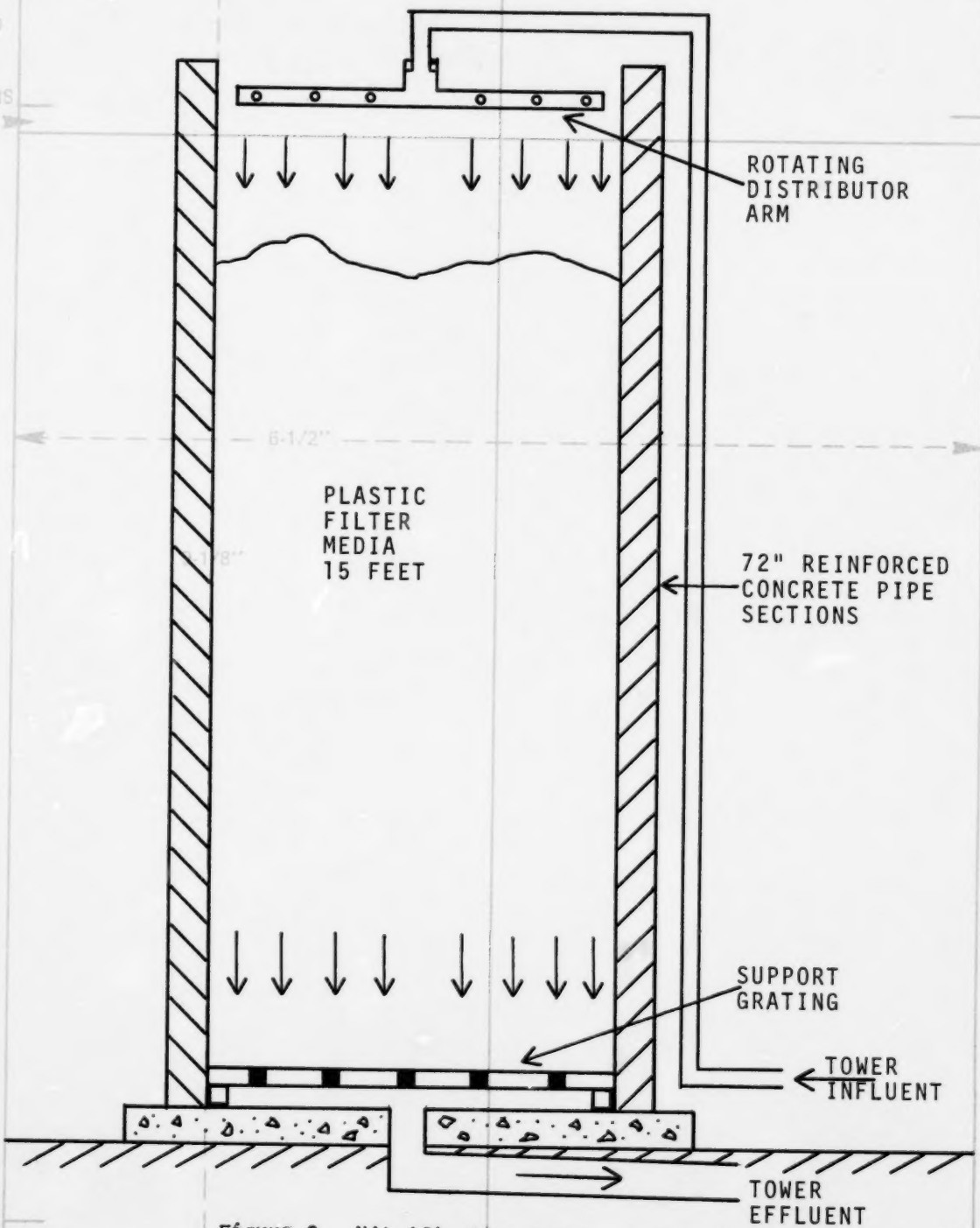

Figure 2. Nitrification tower cross section.

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Granular Activated Carbon Columns

Two granular activated carbon columns were used to provide removal of dissolved organic matter, either prior to final discharge or preceding the nitrification towers in the case of high dissolved organics in the clarifier effluent. The two columns were operated in series with the first column being an upflow type and the second column being of the downflow design. Empty-bed contact time for each filter was approximately 21.6 minutes. Each 4-foot diameter by 8-foot tall column contained approximately 4 feet of granular activated carbon (Calgon Filtrasorb 300) underlain by a 1-foot layer of selected gravel. Flow was introduced into the upflow column via a perforated distributor buried in the supporting gravel layer. In order to maintain a fluidized condition within the carbon bed at a liquid upflow rate of only 2.8 gallons per minute per square foot, a stream of air was also introduced at a manually controlled rate through a second perforated distributor within the gravel layer. Overflow from the upflow carbon column was screened prior to gravity flow to the surface of the downflow column. Because of the filtering nature of the downflow carbon column, backwash facilities were incorporated into its design. As with the pressure filter, the chlorine contact tank served as the backwash water source, and backwash overflow was returned to the head end of the flow equalization tank. The backwash flow rate was on the order of 8.0 gallons per minute per square foot of surface area and was regulated through a constant-flow control valve. Backwash operation was automatic at operator selectable intervals on a 24-hour time clock and provided for a surface spray wash during the backwash cycle.

Effluent Subsystem

The effluent subsystem included the metering device for recording plant flow and the chlorination facilities for disinfection of the final effluent. The chlorine contact tank size of 1,178 gallons provided a contact time of 33.6 minutes at rated flow. Chlorine was fed from 100 pound liquid chlorine cylinders using a solution feed, vacuum operated gas chlorinator mounted directly on the cylinder. The operating vacuum was provided by a hydraulic injector unit, with a close-coupled diffuser attached to a submersible pump mounted on the contact tank floor. In addition to providing the desired contact time for effective effluent chlorination, the tank served as a backwash reservoir for the pressure filter and downflow carbon column.

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Sludge Handling Facilities

An 8,000-gallon rectangular sludge storage tank was provided to handle the lime sludge settled within the chemical clarification unit. As lime sludges generally show good settling properties, provisions were made to thicken the lime sludge by gravity settling. Supernatant drawoff ports were placed at selected elevations along the upper section of the sludge storage tank to allow decanting the supernatant during settling. The decant from the sludge storage-thickening unit was returned to the head end of the flow equalization tank.

A diffused-air system was installed to prevent the formation of anaerobic conditions, prevent settling and excessive compacting, and facilitate removal of heavier solids. Couplings were installed at the bottom sludge draw-off valve to allow tank truck disposal of excess accumulated solids. The design and intent of the sludge storage-thickening unit was to allow the aeration system to be used until shortly before draw-off. This would allow the sludge to settle and thicken and maximize the separation between solids and liquid before draw-off commenced.

ANALYTICAL PROGRAM

Samples were collected consistently throughout the projects duration from six primary sampling points. These sampling points have been designated in Figure 3, which also represents a schematic of the primary flow mode employed during the sample collection period. The lettering code and sample point designation used was as follows:

I --- Plant Influent

C --- Clarifier Effluent (Before Neutralization)

A --- Clarifier Effluent (After Neutralization)

N --- Nitrification Tower Effluent

F --- Mixed Media Filter Effluent

E --- Plant Effluent

In addition, periodic sampling was conducted at selected points to monitor plant efficiency and determine other parameters of secondary interest.

Samples from two points, plant influent and plant effluent, were taken with automatic compositing devices and held under refrigerated conditions prior to analysis. Influent samples

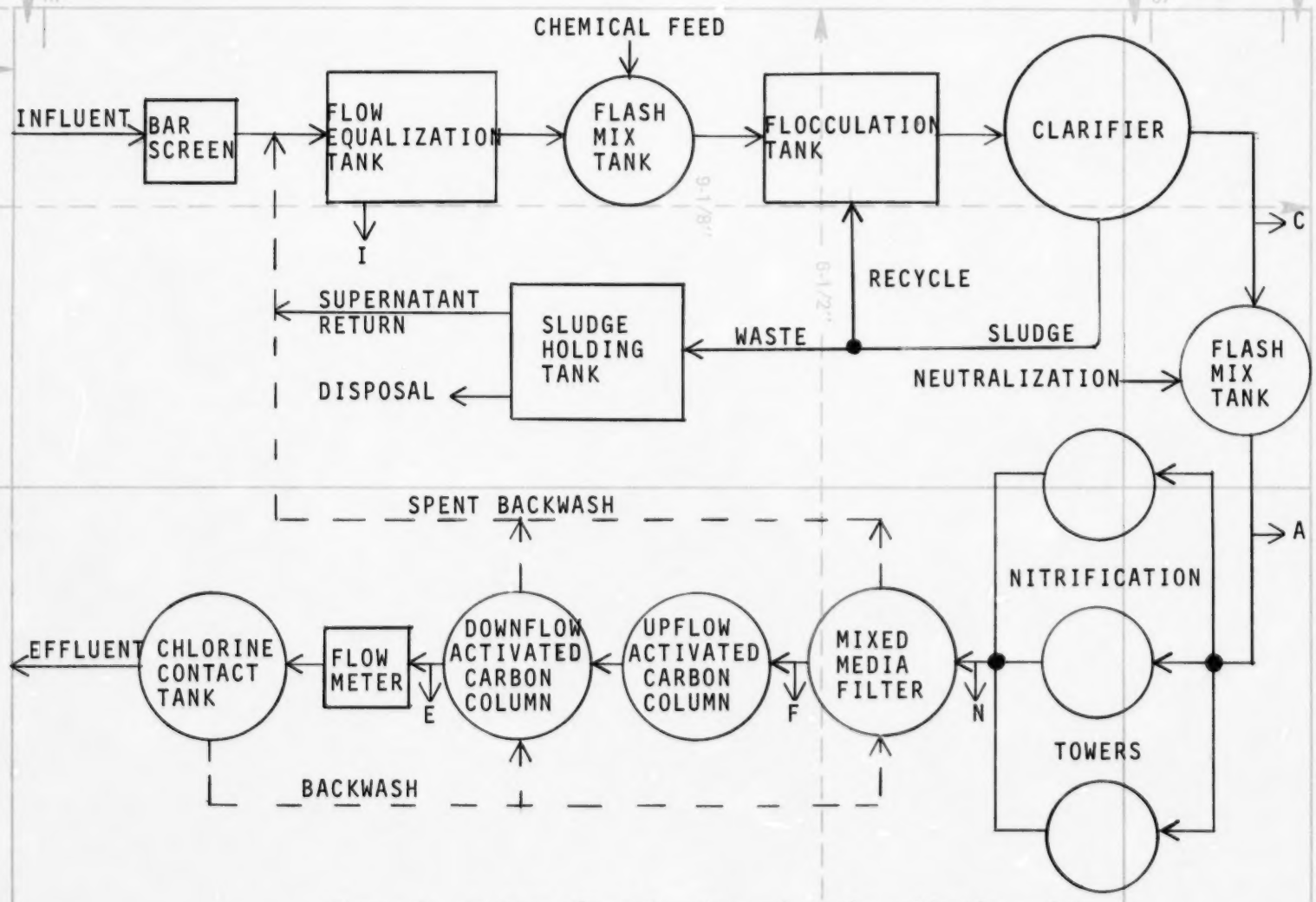

Figure 3. Primary flow schematic and sample collection points.

were collected at hourly intervals from the flow equalization tank so as to provide a uniform, well mixed sample. Effluent samples were collected at 20 minute intervals from the pressurized piping entering the chlorine contact tank so as to avoid the analytical problems associated with chlorinated samples. Grab samples were employed for all other sampling locations and were refrigerated until analyzed.

Composite samples were prepared at 24 hour intervals 5 times each week at 9:00 a.m. Sample collection commenced on Sunday of each week and continued daily until Friday.

Except for selected periods when weekend sampling was conducted, the influent sampler was shut down following the Friday composite make up. The effluent sampler continued in operation to provide composite samples for select analyses run on a daily basis.

In addition to refrigerated storage, samples intended for chemical oxygen demand, total organic carbon, total Kjeldahl nitrogen, ammonia nitrogen (NH_3-N), nitrite nitrogen (NO_2-N), nitrate nitrogen (NO_3-N), acid-hydrolyzable phosphate and orthophosphate were further preserved by the addition of 2 ml of sulfuric acid (H_2SO_4) per liter of sample following collection. These samples were refrigerated until they were delivered to the laboratory for subsequent analysis, usually 3 times per week. Samples for biochemical oxygen demand and suspended solids anaylsis received no acid preservation but were held under refrigerated conditions and analyzed the day after collection. All other tests were performed immediately following collection.

All testing was done in conformance with "Standard Methods for Examination of Water and Wastewater", Fourteenth Edition 1975 (2). These analytical methods are referenced as follows: biochemical oxygen demand, Part 507; chemical oxygen demand, Part 508; total organic carbon, Part 505; Kjeldahl nitrogen, Part 421; ammonia nitrogen, Part 418; nitrite nitrogen, Part 420; nitrate nitrogen, Part 419; acid-hydrolyzable and orthophosphate, Part 425; suspended solids, Part 208 D; volatile suspended solids, Part 208 E; pH, Part 424; turbidity, Part 214 A; temperature, Part 212.

Results of all analyses are presented in the Appendix.

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SECTION 5

RESULTS AND DISCUSSION

WASTE CHARACTERIZATION STUDY

Prior to final design of the demonstration plant, a waste characterization study was conducted on the sewage flow from the area to be served in order to verify design parameters and identify any unusual characteristics the waste might exhibit. Samples were collected and anlayzed over a 3-month period from April to July of 1974. The results, as shown in Table 2, indicate a sewage flow with characteristics that would normally be expected from a strictly residential area, with the possible exception of the suspended solids. The suspended solids results were higher than expected at 411 mg/l. In addition, flocculation studies were conducted which evaluated the use of lime and aluminum sulfate (alum) as possible chemical coagulants. Economic considerations dictated the use of lime. Based on these results, design proceeded as planned.

PRE-OPERATIONAL PHASE

The application for federal assistance entitled, "Interim Wastewater Treatment Plant Demonstration", was submitted to the U. S. Environmental Protection Agency in April, 1973 and was subsequently selected for award in late June of 1973. The original project schedule called for completion of project planning, laboratory-pilot plant studies and plant design and specification phases within 4 months of the grant award. However, it was not until February, 1975 that the consultant serving as the prime contractor for the project had completed the design work and bids were received for providing the required equipment. Due to the nature of the project and the equipment required, two separate contracts were to be awarded. Contract No. 1 covered the majority of the actural process equipment. Contract No. 2 covered site work, nitrification towers, flow equalization tank, sludge storage/thickner tank, and miscellaneous items. All bids on both contracts were rejected due to bid submissions that were considerably in excess of the budget limits of the project. This phase of the project coincided with a period of economic unrest characterized by rapidly escalating costs and severe materials shortages with long delivery times.

At this point, negotiations with the low bidders on each

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TABLE 2. WASTEWATER CHARACTERISTICS*

SAMPLE**	BOD_5	COD	TS	VTS	SS	VSS	DS	VDS	pH	ALKALINITY
No. 1	224	320	1498	876	388	256	1110	620	***	***
No. 2	165	277	1253	***	902	***	351	***	***	***
No. 3	159	361	932	448	485	260	447	188	***	***
No. 4	216	317	824	391	307	250	517	141	***	***
No. 5	260	370	836	512	278	255	558	257	7.0	***
No. 6	***	***	877	378	428	193	449	185	6.8	271
No. 7	295	***	739	324	138	62	601	262	6.9	248
No. 8	***	323	941	445	462	249	479	195	7.0	272
No. 9	***	424	863	361	315	223	548	139	7.0	298
No. 10	357	564	***	***	***	***	***	***	7.1	299
MEAN	239	370	974	467	411	219	562	248	7.0	278

* All results expressed as mg/l, except pH.

** Each sample represents a 24 hour composite.

*** Undefined data.

contract coupled with numerous design changes allowed for the signing of contracts within original projected budget estimates. The design changes, while allowing reductions in costs, retained the basic design concepts and in no way limited the scope or objectives of the original project. Contract No.1, signed in June 1975, called for completion by February 2, 1976. All work progressed as scheduled on Contract No. 1 and all obligations under this contract were completed during January 1976. Contract No. 2, signed in July, 1975 was to be completed by November 24, 1975. At the end of the contract period a considerable amount of work remained to be completed. In early 1976 it became apparent that the contractor was experiencing financial difficulties. Finally, in September 1976, the contractor for Contract No. 2 petitioned for bankruptcy. After several futile attempts to arrange completion of the required work remaining through the Bonding Company and/or parent company of the original contracor, the Sanitation District moved in July 1977 to attempt completion of the construction phase of the project so that the operational and data collection phase could commence as soon as possible. The remainder of 1977 was consumed in attempting to complete the construction phase and place the units in operation.

MISCELLANEOUS PROBLEMS

During the attempts to check out each individual unit and verify its proper operation, numerous problems were encountered. The treatment unit was designed for above ground operation. This design was chosen to allow for short installation time and to facilitate movement to another locality, should the need arise. Equipment supplied under Contract No. 1 was delivered to the site in January 1976. Proper precautions were not taken to protect the units during their long storage awaiting completion of the second contract. This period of inactivation also corresponded to two winter seasons of unusually cold weather. Numerous pipes, valves, fittings and pumps were found to have sustained substantial freeze damage requiring replacement or repair. In addition, prolonged exposure to the elements of pumps and motors when they were not in service, necessitated extensive repairs prior to start-up. Breakdowns encountered with pumps and motors continued to be a major problem during the entire operational phase of the project, no doubt resulting from the long exposure encountered.

CLARIFIER EFFICIENCY

Average BOD_5 strength of the waste delivered to the clarification unit was somewhat lower than expected at 159 mg/l. Possibly some removals took place within the aerated flow equalization tank prior to pumping to the clarification unit, as retention time within the flow equalization tank was generally in the range of 5 to 10 hours. Also, a significant amount

of infiltration was noted. However, the recycle streams should have offset these factors. BOD_5 removals within the clarification unit averaged 77 percent over the days where samples were analyzed before and after this subsytem. The resulting effluent BOD_5 concentration averaged 38 mg/l. In addition to BOD_5 determinations, several other parameters were monitored to evaluate the organic removal efficiency of the clarifier. As illustrated in Table 3, the results obtained on chemical oxygen demand (COD), total organic carbon (TOC), and suspended solids (SS) show removals similar to those obtained for BOD_5.

Some total nitrogen reduction was noted during the clarification step. The decrease from an average of 38 mg/l on the influent to 33 mg/l on the clarifier effluent represents 5 mg/l, or a decrease of 13.2%. An analysis of the nitrogen balance indicates that much of the organic nitrogen was either hydrolyzed to ammonia nitrogen or removed with the settled sludge. Some of the ammonia nitrogen may also have been volatilized to account for some of the total nitrogen removal. Significant changes in the concentrations of the nitrite and nitrate nitrogen forms were not expected and the results show little change.

An added benefit of lime clarification is the removal of substantial amounts of phosphorus. Calcium ions, added as lime, react with the phosphates in the presence of the hydroxyl ion to form precipitates which settle out. Data during the study period showed acid-hydrolyzable phosphorus concentrations of the influent wastewater flow to be 12.1 mg/l. Acid-hydrolyzable phosphorus removal during clarification averaged 82%, in spite of the problems encountered with controlling lime feed dosages. During the early part of the study period, the lime dosage was increased in an effort to improve phosphorus, suspended solids, and organic removal during clarification. As shown in Table 4, during the initial operation of the treatment plant between week 1 and week 6 when clarifier pH valves averaged 10.7, removal of the acid-hydrolyzable phosphorus averaged 63%. Following the increase (after 6 weeks) in lime feed and the resulting increase in average pH values to 11.5, acid-hyrdolyzable phosphorus removal increased to 85% for weeks 7 through 12. When clarifier sludge recycle was discontinued after week 12, removals remained similar at 87%. Few other significant changes were noted in latter treatment processes, with phosphorus concentrations leaving the treatment plant being very near (average 2.7 mg/l) those found in the clarifier effluent (average 2.2 mg/l).

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TABLE 3. ORGANIC REMOVAL DURING LIME CLARIFICATION*

PARAMETER	CLARIFIER INFLUENT (mg/l)	CLARIFIER EFFLUENT (mg/l)	% EFFICIENCY
Biochemical Oxygen Demand (BOD_5)	162	38	77
Suspended Solids (SS)	285	39	86
Chemical Oxygen Demand (COD)	437	119	73
Total Organic Carbon (TOC)	112	38	66

* Figures represent paired samples where influent and effluent analyses were performed.

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TABLE 4. ACID-HYDROLYZABLE PHOSPHORUS REMOVAL DURING LIME CLARIFICATION*

	CLARIFIER INFLUENT (mg/l)	CLARIFIER EFFLUENT (mg/l)	% REMOVAL
LOW LIME FEED (pH 10.7) with recycle (weeks 1-6)	11.4	4.2	63
HIGH LIME FEED (pH 11.5) with recycle (weeks 7-12)	9.5	1.4	85
HIGH LIME FEED (pH 11.4) without recycle (weeks 13-20)	14.0	1.8	87

* Figures represent paired samples where influent and effluent analysis were performed.

After approximately 12 weeks of clarifier operation, attempt was made to improve the clarifier efficiency by discontinuing the recycle of settled sludge back to the flocculation tank. Operation up until this time involved complete sludge recycle except for periods of sludge wasting to the holding tank. During those final 8 weeks of plant operation, no sludge was recycled, with only sludge withdrawal from the clarifier continued on an intermittent basis for sludge wasting purposes. As illustrated in Table 4, this procedure had little effect on clarifier performance as measured by acid-hydrolyzable phosphorus, and no significant changes were noted with other parameters used to measure clarifier efficiency.

NITRIFICATION TOWER PERFORMANCE

Initial plans were to speed the development of a bacterial growth capable of producing nitrification by seeding the towers with a population developed in the laboratory under low carbonaceous feed conditions. Due to the long delay in commencing operation of the demonstration plant, the developed bacterial growths were never used. Prior to actual start-up at the site, an attempt was made to seed the nitrification towers with waste sludge from an activated sludge plant achieving some degree of nitrification by virtue of a high sludge age. The sump pit at the base of the nitrification towers served as a collection point for effluent flow from all three towers and had a volume of about 200 gallons. The piping arrangement was designed to allow recirculation of this flow back to the nitrification towers influent. On the two occasions when seeding was attempted, seepage along the base of the towers quickly depleted this volume. At that point, it was decided to allow the nitrifying

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bacteria to develop as the project progressed. This would allow for careful observation and documentation of the developing nitrifying growth under actual operating conditions and provide data on changes that might occur within the treatment system.

It was expected that a period of 4 to 6 weeks would be required to develop a nitrifying bacterial growth on the plastic media in the nitrification towers. At the end of that period it was obvious, however, that the towers were not supporting the required organisms, as very little conversion of ammonia nitrogen to the nitrate form was evident. Attempts were made to improve the quality of the flow to the towers by improving clarifier performance. Lime feed rates were adjusted in hopes of further reducing the carbonaceous loading to the towers. Attempts were also made to obtain better control of the acid neutralization feed system used to reduce the high pH flow from the clarifier, as previous studies had indicated that nitrifying bacteria show greater sensitivity to pH conditions than carbon oxidizing growths. The pH feed to the towers was also increased to more closely approximate the 8.4 value indicated as being ideal for their growth. However, all attempts to bring about high levels of nitrification within the plastic media towers were unsuccessful.

Although the nitrogen conversion results were not as significant as anticipated, the results obtained using paired data shows rather substantial removals of organics through the nitrification towers. BOD_5 and TOC removals were 44% and 42%, respectively. Organic removals as measured by COD results were lower at 13% nitrate and nitrite concentrations combined increased an average of only 1.4 mg/l during passage through the towers, and never more than 4.2 mg/l.

Several factors were evaluated in an effort to determine the reason for the low levels of nitrification taking place. Phosphorus requirements in a separate stage nitrification system preceded by a chemical primary treatment step are a concern (1). Low levels of phosphorus resulting from primary chemical treatment can act as a limiting nutrient for the biomass on the nitrification tower filters. During the course of this project inorganic phosphorus levels (orthophosphate plus acid-hydrolyzable phosphate) of the nitrification tower influent averaged 4.1 mg/l and on only one occasion dropped below the 1 mg/l requirement which is considered a maximum requirement for separate stage nitrification. Surface area requirements of the tower media need to be about 7,250 square feet per pound of ammonia nitrogen oxidized per day in order to provide sufficient biological film development (1). Based on an ammonia concentration of 25 mg/l during the project period, the design of the nitrification towers provided about 8,800 sq. ft./lb. of ammonia-N oxidized per day, well in excess of

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the required surface area. Actual results showed only about 0.46 pounds of ammonia nitrogen oxidized per day. In addition, organic loading to the nitrification towers was evaluated. Research clearly indicates that organic loading significantly affects nitrification efficiency, principally by displacement of the nitrifiers from the media surface by heterotrophic organisms. During the full data collection period, organic loadings to the towers, as measured by BOD_5, averaged 12.2 pounds per day, or about 9.5 lb./1000 cu.ft./day. It had been shown that 90% nitrification could be expected using plastic media (27 sq.ft./cu.ft.) at loadings of 25 lb. BOD_5/1000 cu.ft./day (1). The plastic media used in the project towers had a surface area of 57 sq. ft./cu.ft. This would normally allow BOD_5 loading well in excess of the 25 lb./1000 cu.ft./day noted in the above reference.

A review of the above data and other controlling factors affecting nitrification would indicate that the lack of recirculation is the primary reason for the low levels of nitrification experienced. Hydraulic loading to the towers was 0.4 gallons per minute per square foot at design flow. This is slightly less than the 0.5 to 1.0 gallons per minute per square foot considered a minimum application rate (1). This application rate is considered the minimum to ensure uniform wetting of the media surface and avoiding drying out of portions of the biomass. A recommendation of recirculation capabilities is made in reference 1, with a 1:1 recirculation ratio being considered adequate. Recirculation ratios well in excess of the 1:1 ratio have also proven effective.

MIXED MEDIA FILTRATION

The mixed media pressure filtration system was originally calculated to be capable of handling the anticipated solids production from the nitrification towers. Previous studies and experience had shown that very little solids production occurs during the nitrification reaction (1). The oxidation of carbonaceous waste as experienced in the trickling filter or activated sludge system results in a considerable increase in suspended matter that must be removed from the system. Due to the lack of nitrification taking place within the towers and the carbonaceous oxidation occurring (BOD_5 and TOC removals were in excess of 40%), extensive sloughing was experienced from the nitrification towers. An examination of paired data points on influent and effluent values shows suspended solids increased during passage through the nitrification towers from 21 mg/l to 44 mg/l. An increase of about 110%. Accordingly, filter backwashing requirements were considerably greater than anticipated. In the filter design the manufacturer anticipated a backwash requirement of no more than once per 24 hours to maintain the design flow rate of 50,000 gpd for the system.

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Based on the backwashing criterion of terminal headloss at approximately 10 feet, filter runs were frequently as short as 4 hours, with considerable clogging occurring even with these short filter run times. Filter runs in excess of 12 hours were experienced rarely, with the normal run being 6-8 hours. Despite the sever demands placed upon the filter and clogging that occurred on occasion between backwashing, headloss recovery was generally complete following the backwash sequence. Although the length of the various backwash functions was adjustable, no condition arose that necessitated their change.

Considering the solids load placed upon the mixed media filter, removals were considered good. As Table 5 shows, suspended solids concentrations were reduced from an average of 44 mg/l to 13 mg/l, based on paired data points. This represents a 70% removal, which is quite comparable to other results (3). Other parameters were less affected by the filtration. COD associated with suspended matter was reduced from 101 mg/l to 61 mg/l (40% reduction), while TOC and phosphorus concentrations were hardly changed. No paired data were available for BOD_5, but over the operating period the average filter influent concentration was 26 mg/l and the average effluent concentrations was 14 mg/l (46% reduction). Some nitrogen removal (11%) was evident from the data also.

TABLE 5. MIXED MEDIA FILTER PERFORMANCE *

PARAMETER	FILTER INFLUENT (mg/l)	FILTER EFFLUENT (mg/l)	% REMOVAL
Chemical Oxygen Demand	101	61	40
Total Organic Carbon	21	20	5
Suspended Solids	44	13	70
Acid-hydrolyzable Phosphorus	2.3	1.9	17
Total Nitrogen	32.5	29	11

* Figures represent paired samples where influent and effluent analysis were performed.

ACTIVATED CARBON COLUMNS

Two granular activated carbon columns were provided for

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removal of dissolved organic matter remaining in the flow from proceeding units prior to discharge. The units were operated in series, with the first carbon unit being of the upflow air-fluidized type and the second carbon unit being a downflow column. The design of the second carbon column being downflow necessitated a periodic backwash to prevent surface clogging. The problem of solids buildup on the downflow carbon column was not evident as it was with the mixed media filter. Considerably longer filter run times were possible before head loss build up was evident. Carbon column run backwash intervals of 24 hours proved to be no problem. Obviously, the pressure filter removal of suspended material assisted in this accomplishment. However, the downflow design of the final filter did provide for some addition removal of suspended solids (39% based on paired data) prior to discharge.

Although the carbon filters were designed with the capability of transferring spent carbon from the system and replenishing with fresh carbon as required, the short operating period obviated the use of this system. Previous studies had indicated that activated carbon adsorber influents containing nitrates resulted in extended activated carbon life spans, some nitrogen removal, and elimination of hydrogen sulfide odors (4). Although the operating period was too short to confirm any increased life of the activated carbon, the COD removed by the adsorption process had reached 0.18 lb. COD per lb. of activated carbon at project termination. This cumulative loading combined with the fact that no noticeable reduction in removal had occurred at project termination indicates that the carbon had not been exhausted. Actual removals using paired data indicate that BOD_5 and TOC were reduced by 4 mg/l, from 12 mg/l to 8 mg/l and from 20 mg/l to 16 mg/l, respectively. COD reduction from 61 mg/l to 51 mg/l also occurred. These removals are generally low when compared to data results of most other independent physical-chemical systems. The downflow activated carbon column also further reduced the suspended solids concentration from an influent value of 13 mg/l to 8 mg/l in the effluent.

The difficulties frequently related to hydrogen sulfide generation in carbon columns of the type employed did not materialize. Even though nitrate concentrations in the carbon column feed were less than anticipated, they were apparently sufficient to act as preferential combined oxygen sources to sulfates. This is verified not only be the lack of hydrogen sulfide odor problems, but by the residual NO_2-N and NO_3-N in the final effluent of 0.6 mg/l. Nitrate and nitrite levels decreased from about 3.5 mg/l to 0.6 mg/l in passage through the carbon adsorbers. This accounted for the 3 mg/l of total nitrogen loss, primarliy by denitrification in the carbon columns.

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POLLUTANT PROFILE

An evaluation was made of the data obtained on each measured parameter as it passed through the subsystems of the plant. A summary of this data is shown in Table 6, indicating the percent pollutant removals obtained with each subsystem and cumulative percent removals as the waste flow progressed through the system. As expected, most of the BOD_5 was removed during the primary chemical clarification step (77%). Each of the following subsystems also contributed additional BOD_5 removal. As discussed previously, significant carbonaceous oxidation was evident in the nitrification towers and contributed to further removal of the BOD_5 as is shown by the 44% reduction. Although paired BOD_5 data were not available for the mixed-media filter, limited unpaired data showed additional removal of suspended BOD_5. The activated carbon columns contributed to removal of both dissolved BOD_5 by adsorption and suspended BOD_5 by virtue of the filtering action of the down-flow carbon column. Final effluent BOD_5 removal after carbon adsorption averaged 93% compared to average influent BOD_5 values.

Organic removal as measured by COD and TOC were for the most part equivalent to that obtained for BOD_5 during passage through the system. One noticeable difference is the low TOC removal experienced through the mixed media filter. This would indicate that a major portion of the TOC was in the soluble form and not removable as suspended matter.

Suspended solids removal during primary clarification averaged 86%. No suspended solids removal was expected during nitrification, as this process was intended to function as a conversion process. As discussed previously, the quantity of suspended solids generated was significantly greater than expected and the data showed a 110% increase through the nitrification towers. This was due to the carbonaceous oxidation that occurred which generates significantly greater quantities of suspended solids than the nitrogenous oxidation which was anticipated. Most of the suspended solids passing from the towers were removed by the mixed-media filter which followed. Considering that the solids loading to the filter was well in excess of the design loading, removals were excellent. Suspended solids leaving the filter were reduced 95% from the plant influent values. Suspended solids were reduced still further by the activated carbon columns. This was due to the filtering nature of the final carbon column which was of the down-flow design. Final effluent values of suspended solids during the entire project period averaged 8 mg/l, which represents an overall reduction of better than 97%.

As expected, the only significant reduction in phosphorus concentration occurred during the lime clarification step.

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TABLE 6. PROJECT DATA SUMMARY

SUBSYSTEM	PARAMETER MEASURED* BOD_5(mg/l)	COD(mg/l)	TOC(mg/l)	SS(mg/l)	AHP(mg/l)**	TN(mg/l)***
CLARIFIER						
%Removal	77	73	66	86	82	13
%Cumulative	77	73	66	86	82	13
NITRIFICATION						
%Removal	44	13	42	Neg.	Neg.	Neg.
%Cumulative	84	76	80	85	80	11
MIXED-MEDIA FILTER						
%Removal	--	40	5	71	17	11
%Cumulative	91	86	82	95	85	24
CARBON COLUMNS						
%Removal	33	15	20	39	Neg.	10
%Cumulative	93	88	86	97	80	32

* Data represents paired samples where influent and effluent analyses were performed.

** Acid-Hydrolyzable Phosphorus

*** Total Nitrogen

Removals of both acid-hydrolyzable and orthophosphate were in excess of 80% for the entire project period. During operating weeks 7 through 20 when relatively higher levels of lime were used for clarification, removals were in excess of 85% (see Table 4). Phosphorus levels during latter treatment processes remained relatively unchanged.

Total nitrogen levels during treatment were reduced from an influent value of 38 mg/l to 26 mg/l in the effluent, a reduction of 32%. Most of this reduction was in the form of organic nitrogen, as the ammonia, nitrite, and nitrate forms showed little variation between influent and effluent values. The greatest reduction in total nitrogen occurred during the clarification step (13%), where much of the organic nitrogen was either removed with the settled material or hydrolyzed to the ammonia form and subsequently volatilized. Although no significant total nitrogen changes were expected during passage through the nitrification towers, it was expected that ammonia levels would decrease, with corresponding increases in the nitrite and nitrate nitrogen forms. As discussed previously, the changes in nitrogen form were minimal. Nitrite and nitrate nitrogen combined increased an average of 1.4 mg/l with 4.2 mg/l being the maximum increase. Some additional total nitrogen reduction occurred during the filtration and carbon adsorption steps and resulted in an overall plant removal of 32%.

PERFORMANCE AND RELIABILITY

One of the outstanding features of the treatment system noted throughout the period of operation was the reliability with which a high quality effluent could be produced. In spite of equipment and operational problems encountered, the treatment system as designed was able to adjust and produce a consistent high quality effluent.

Performance and reliability data based on average process performance over the entire operating period has been evaluated and compared to common biological type treatment systems. The basis for the data on other biological systems was taken from Reference 5 and represents data collected during a five-year period from approximately 350 secondary wastewater treatment facilities. This US EPA publication states that this data is "one of the best available statements of actual performance of existing wastewater facilities now available". The data has been summarized and is presented in Table 7. Seven types of biological treatment systems are listed, along with the data obtained from the demonstration plant which is listed at the bottom. This summary clearly shows that the demonstration plant was able to produce effluent BOD_5, COD, and SS concentrations well below those produced by other processes. Generally speaking, of the seven other processes listed, the oxidation ditch produced the best overall effluent (5). Except for ammonia

TABLE 7. SUMMARY OF COMMON BIOLOGICAL PROCESS PERFORMANCE

TYPE FACILITY	AVERAGE EFFLUENT VALUES			
	BOD_5(mg/l)	COD(mg/l)	SS(mg/l)	NH_3-N(mg/l)
Lagoons	28	115	47	5.9
Activated Sludge	23	75	25	10.9
Trickling Filters	42	117	37	13.4
Oxidation Ditch	17	66	17	6.4
Rotating Bilogical Surface	54	126	23	13.0
Activated Biological Filter	31	100	17	17.7
Package STP'S	48	121	50	8.5
AVERAGE-TOTAL PLANTS	35	103	31	10.8
DEMONSTRATION PLANT	11	54	8	22.3

nitrogen, the demonstration plant average effluent values were well below those indicated for the oxidation ditch.

Reliability curves have been developed to indicate the frequency or probability of the occurrence of specific effluent values. This type of presentation includes both high and low values and as such presents amore complete and realistic assessment of the capabilities of a treatment system to produce effluents of a given quality. The reliability curves have been developed from the actual daily effluent values rather than from averaged data which would remove the data highs and lows. BOD_5 and suspended solids effluent values have been used to exemplify the reliability of treatment from the system (Figures 4 and 5). For comparative purposes, the data from a survey of extended aeration and contact stabilization package plants has been shown also (6). These plants ranged in size for 0.05 to 1.0 mgd and were treating domestic sewage. As the figures so dramatically indicate, the system employed produced considerably lower effluent values on a more consistent basis than the package type treatment systems.

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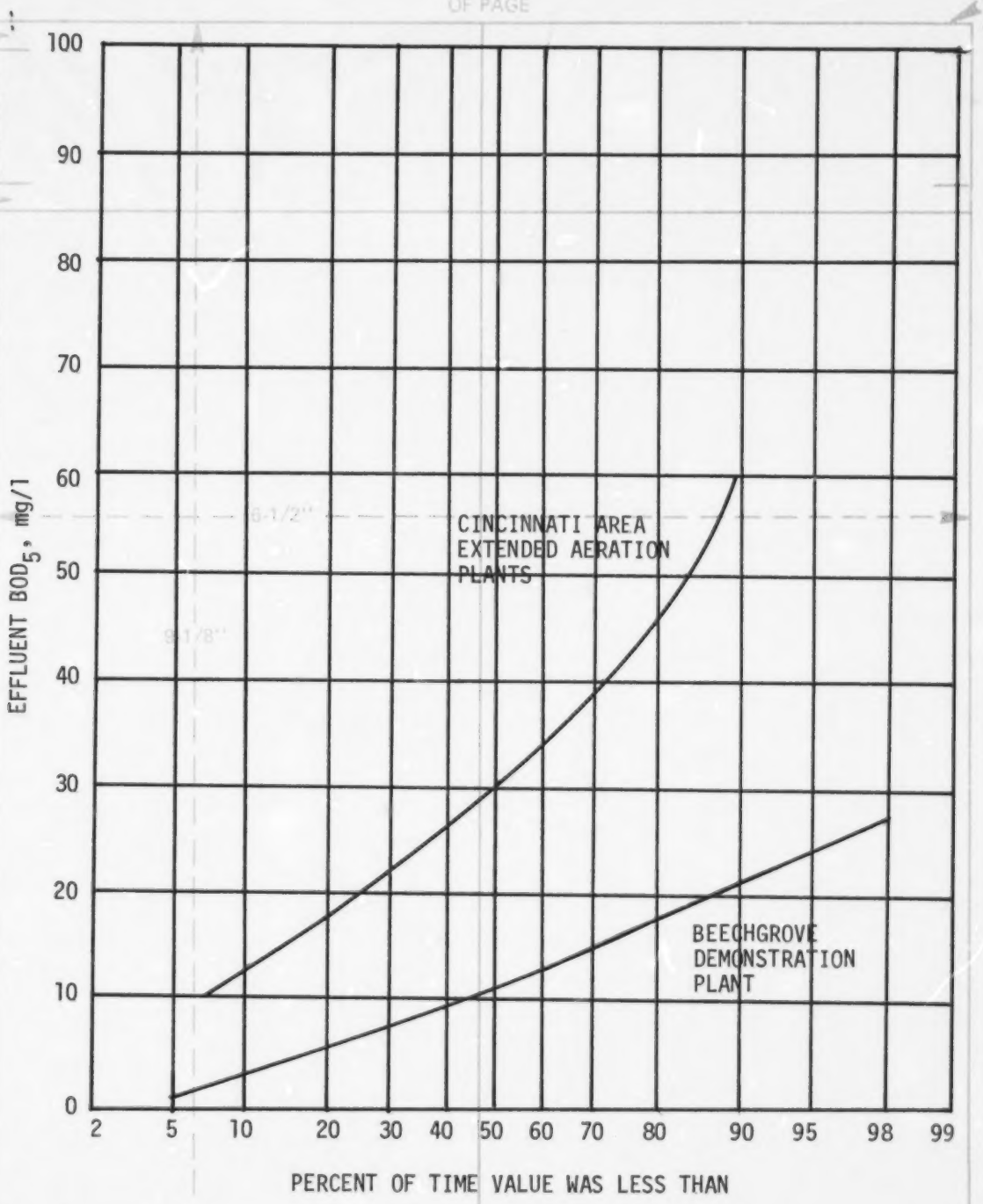

Figure 4. Comparison of BOD_5 reliability.

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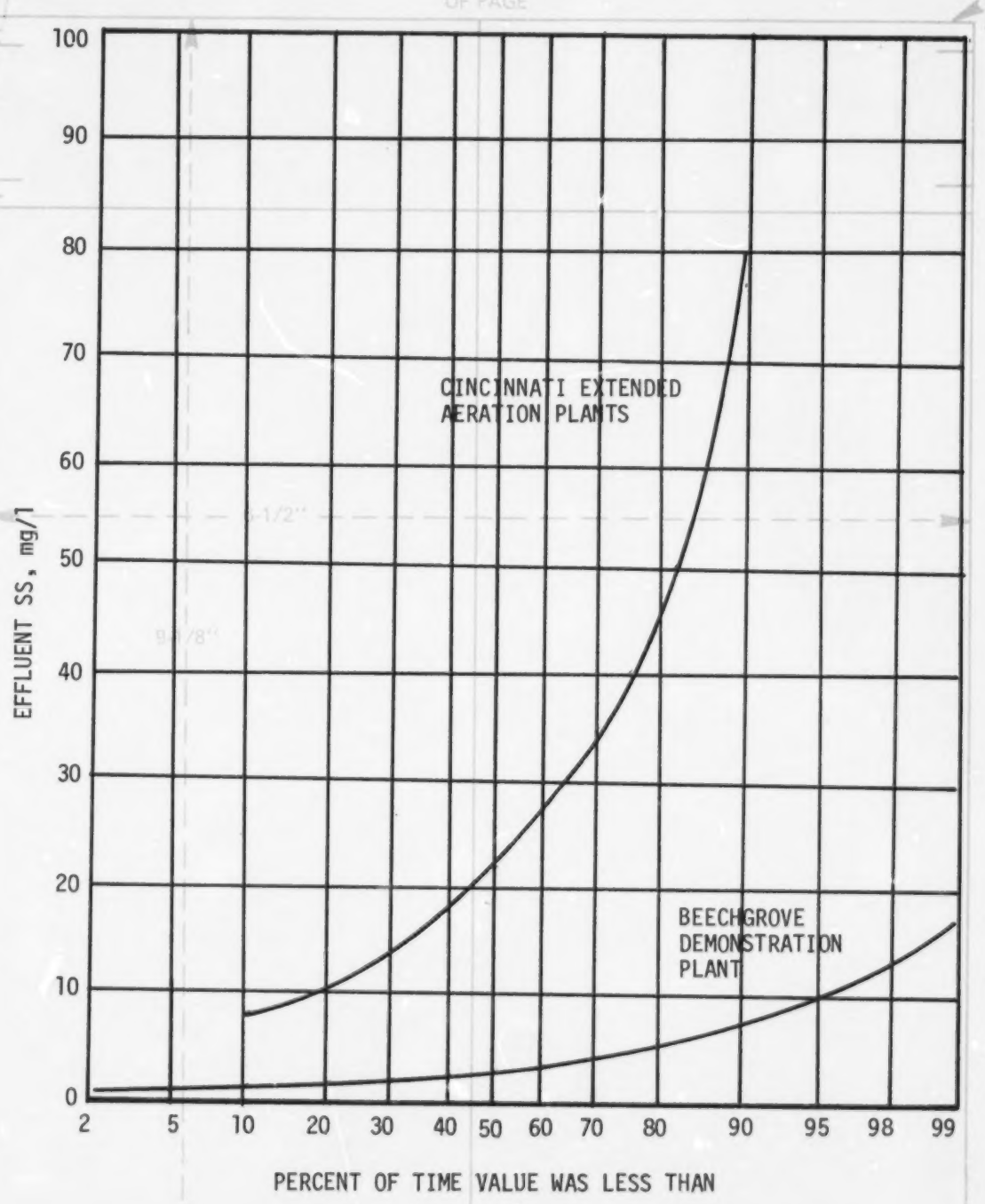

Figure 5. Comparison of Suspended Solids reliability.

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SECTION 6

OPERATION AND MAINTENANCE

NORMAL OPERATION AND MAINTENANCE REQUIREMENTS

The normal operation and maintenance of the demonstration plant was of necessity more time consuming and complex than that associated with most biological treatment plants. One full time person was assigned to the plant for normal operation and maintenance, and additional manpower was added for any unusual problems that developed. Weekend coverage was also provided. Their duties included not only operation and maintenance, but also included laboratory testing required at the site, sampling, sample preparation and delivery, preparation of logs and records and other miscellaneous tasks associated with the plant due to its experimental nature. Following is a listing of the normal operation and maintenance functions observed by plant personnel.

Daily operation and maintenance functions:

1. Clean influent bar screen to flow equilization tank.
2. Check flow equalization tank level.
3. Clean floatables from flow equalization tank.
4. Observe and adjust air volume and distribution in flow equalization tank as required.
5. Check influent pump.
6. Check air blower.
7. Verify operation of lime flash mix tank mixer and clean propellor.
8. Verify operation of flocculation tank mixer and clean propellor.
9. Observe and adjust speed of flocculation tank mixer as required.
10. Verify clarifier drive operation.
11. Mix contents of clarifier distribution box and observe for evidence of blockage in clarifier distribution piping.
12. Clean floatables from surface of clarifier.
13. Empty container from clarifier skimmer overflow.
14. Hose and clean clarifier weir trough.
15. Hose and clean acid flash mix tank.
16. Verify operation of acid flash mix tank mixer.

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17. Clean upflow carbon tank effluent screen.
18. Observe and adjust air flow in upflow carbon adsorber as required.
19. Check baffle in acid flash mix tank.
20. Clean nitrification tower distributor arm orifices.
21. Observe and adjust distribution of flow to nitrification towers as required.
22. Clean debris from nitrification tower effluent screen.
23. Alternate nitrification tower sump well pumps and verify their proper operation.
24. Observe mixed-media filter influent and effluent pressure gauges and verify proper filter operation.
25. Verify operation of air compressor for upflow carbon column and mixed-media filter.
26. Observe mixed-media filter backwash and verify proper operation.
27. Observe downflow carbon adsorber backwash and verify proper operation.
28. Check chlorine feed rate and adjust as necessary.
29. Verify operation of chlorine ejector pump.
30. Observe and adjust air flow and distribution in sludge holding tank as necessary.
31. Verify proper operation of sludge recirculation and sludge wasting pump.
32. Make up reqired lime slurry supply.
33. Make up required acid supply.
34. Verify proper operation of lime slurry pump.
35. Acid clean lime feed pump.
36. Verify operation of lime slurry tank mixer.
37. Verify proper operation of acid pump and adjust feed rate as necessary.
38. Verify operation of acid tank mixer.
39. Verify proper operation of pH control system.
40. Check inventory of lime and acid supply.
41. Check level of sludge storage-thickener tank and haul excess or decant supernatant as necessary.
42. Hose tank interiors and work area.
43. Conduct laboratory analyses required.
44. Complete log sheets and analyses sheets.
45. Collect, prepare, and deliver samples for analysis as required.

Twice weekly operation and maintenance functions:

1. Inspect and clean pH probes.
2. Standardize pH control system.
3. Clean influent sampler intake screen.

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Weekly operation and maintenance functions:

1. Grease following items:
   a) air compressor bearings
   b) nitrification tower distributor arms
   c) influent pump
   d) sludge wasting pump
   e) clarifier drive speed reducer
2. Check oil level in the following:
   a) air compressor
   b) lime slurry feed pump
   c) acid feed pump
   d) clarifier drive speed reducer
3. Check the following belts for tension and wear:
   a) influent pump
   b) air compressor
   c) sludge wasting pump
   d) lime slurry feed pump
4. Check air compressor intake screen and clean as necessary.
5. Check all probe rods for tightness:
   a) equalization tank (2 sets)
   b) clarifier (2 sets)
   c) acid flash mix tank
   d) downflow carbon adsorber
   e) pressure filter surge tank
   f) downflow carbon adsorber backwash surge tank
   g) chlorine contact tank (2 sets)
6. Pressure flush clarifier distribution piping.
7. Clean flow equalization tank level control probe rods.
8. Check upstream flow diversion manhole.
9. Check flow control system and air supply system.

Periodic as required:

1. Air compressor - change oil each 1500 operating hours.
2. Acid feed pump - change oil each 2,000 operating hours.
3. Clarifier drive speed reducer - change oil each 2500 operating hours.

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REFERENCES

1. "Process Design Manual for Nitrogen Control." U. S. Environmental Protection Agency Technology Transfer (1975).

2. "Standard Methods for the Examination of Water and Wastewater." Fourteenth Edition, American Public Health Association, New York, N. Y. (1975).

3. "Process Design Manual for Suspended Solids Removal." U. S. Environmental Protection Agency Technology Transfer (1975).

4. Directo, L. S., Chen, C. L., and Miele, R. P., "Independent Physical-Chemical Treatment of Raw Sewage." U. S. EPA Environmental Protection Technology Series Report No. EPA-600/2-77-137 (August 1977).

5. "Performance Report. 1978 Winter Municipal Wastewater Treatment Facility." U. S. Environmental Protection Agency Report No. EPA 907/9-79-002 (February 1979).

6. "A comparison of Oxidation Ditch Plants to Competing Processes for Secondary and Advanced Treatment of Municipal Waste." U. S. EPA Environmental Protection Technology Series Report No. EPA-600/2-78-051 (March 1978).

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APPENDIX

DATE	FLOW (gpd)	BOD,mg/l					COD,mg/l				
		I	A	N	F	E	I	A	N	F	E
06-20-78	28,370	124	***	***	***	16	350	***	***	***	60
06-21-78	45,200	140	***	***	***	18	366	***	***	***	66
06-22-78	45,370	151	***	***	***	12	378	***	***	***	55
06-23-78	41,715	***	***	***	***	***	***	***	***	***	***
06-24-78	40,972	***	***	***	***	***	***	***	***	***	***
06-25-78	36,173	***	***	***	***	***	381	***	***	***	68
06-26-78	41,280	***	***	***	***	***	384	141	96	***	66
06-27-78	44,820	153	***	***	***	15	439	***	***	***	59
06-28-78	45,590	120	***	***	***	13	272	107	71	***	49
06-29-78	45,390	173	***	***	***	9	511	***	***	***	47
06-30-78	35,465	***	***	***	***	***	***	***	***	***	***
07-01-78	31,750	***	***	***	***	***	***	***	***	***	***
07-02-78	32,485	***	***	***	***	***	367	96	108	***	64
07-03-78	36,615	***	***	***	***	***	384	124	108	***	107
07-04-78	46,010	129	***	***	***	14	536	***	***	***	70
07-05-78	44,470	176	***	***	***	25	408	141	107	***	74
07-06-78	41,303	179	***	***	***	22	436	***	***	***	75
07-07-78	43,942	***	***	***	***	***	***	***	***	***	***
07-08-78	42,380	***	***	***	***	***	***	***	***	***	***
07-09-78	36,200	***	***	***	***	***	377	***	***	***	60
07-10-78	29,385	***	***	***	***	***	272	92	115	***	53
07-11-78	36,055	120	***	***	***	11	273	***	***	***	56

BOD---BIOCHEMICAL OXYGEN DEMAND
COD---CHEMICAL OXYGEN DEMAND
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
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DATE	FLOW (gpd)	BOD,mg/l (I	A	N	F	E)	COD,mg/l (I	A	N	F	E)
07-12-78	40,300	161	***	***	***	13	300	116	163	***	60
07-13-78	41,770	135	***	***	***	15	400	***	***	***	55
07-14-78	45,110	***	***	***	***	***	***	***	***	***	***
07-15-78	42,570	***	***	***	***	***	***	***	***	***	***
07-16-78	41,400	***	***	***	***	***	422	***	***	***	65
07-17-78	39,820	***	***	***	***	***	431	227	74	***	66
07-18-78	43,550	>557	***	***	***	17	1590	***	***	***	64
07-19-78	44,390	>550	***	***	***	16	2530	256	74	***	65
07-20-78	40,020	280	***	***	***	7	450	***	***	***	55
07-21-78	38,785	***	***	***	***	***	***	***	***	***	***
07-22-78	26,048	***	***	***	***	***	***	***	***	***	***
07-23-78	10,980	***	***	***	***	***	214	***	***	***	58
07-24-78	34,775	***	***	***	***	***	322	129	116	***	50
07-25-78	42,720	79	***	***	***	8	277	***	***	***	42
07-26-78	40,107	134	***	***	***	12	332	159	76	***	42
07-27-78	38,659	104	***	***	***	13	301	***	***	***	44
07-28-78	37,231	***	***	***	***	***	***	***	***	***	***
07-29-78	13,208	***	***	***	***	***	***	***	***	***	***
07-30-78	28,007	***	***	***	***	***	341	***	***	***	45
07-31-78	30,956	***	***	***	***	***	239	72	69	***	37
08-01-78	37,100	83	***	***	***	11	223	***	***	***	31
08-02-78	39,052	118	***	***	***	7	282	111	83	***	32

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DATE	FLOW (gpd)	BOD,mg/l (I	A	N	F	E)	COD,mg/l (I	A	N	F	E)
08-03-78	40,396	139	***	***	***	11	392	***	***	***	40
08-04-78	43,854	***	***	***	***	***	***	***	***	***	***
08-05-78	42,492	***	***	***	***	***	***	***	***	***	***
08-06-78	41,415	***	***	***	***	***	285	***	***	***	52
08-07-78	41,745	***	***	***	***	***	283	109	108	***	106
08-08-78	39,805	99	***	***	***	27	405	***	***	***	82
08-09-78	35,445	90	***	***	***	19	256	130	102	***	45
08-10-78	32,485	94	***	***	***	25	236	***	***	***	73
08-11-78	32,840	***	***	***	***	***	***	***	***	***	***
08-12-78	40,490	***	***	***	***	***	***	***	***	***	***
08-13-78	43,230	***	***	***	***	***	350	***	***	***	42
08-14-78	39,312	***	***	***	***	***	294	70	56	***	37
08-15-78	43,401	205	***	***	***	8	536	***	***	***	43
08-16-78	38,967	119	***	***	***	10	363	66	79	***	47
08-17-78	36,977	105	***	***	***	7	235	***	***	***	39
08-18-78	36,818	***	***	***	***	***	***	***	***	***	***
08-19-78	39,160	***	***	***	***	***	***	***	***	***	***
08-20-78	41,860	***	***	***	***	***	390	***	***	***	39
08-21-78	45,188	***	***	***	***	***	454	100	75	***	41
08-22-78	45,332	152	***	***	***	7	400	***	***	***	40
08-23-78	45,135	128	***	***	***	9	418	94	125	***	46
08-24-78	19,386	50	***	***	***	10	185	***	***	***	47

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		I	A	N	F	E	I	A	N	F	E
08-25-78	45,208	***	***	***	***	***	***	***	***	***	***
08-26-78	45,068	***	***	***	***	***	***	***	***	***	***
08-27-78	45,716	***	***	***	***	***	450	***	***	***	45
08-28-78	45,260	***	***	***	***	***	580	135	140	***	50
08-29-78	43,551	147	***	***	***	11	480	***	***	***	50
08-30-78	44,476	133	***	***	***	8	430	140	160	***	70
08-31-78	46,311	91	***	***	***	6	350	***	***	***	55
09-01-78	45,559	***	***	***	***	***	***	***	***	***	***
09-02-78	45,810	***	***	***	***	***	***	***	***	***	***
09-03-78	40,070	***	***	***	***	***	369	***	***	***	43
09-04-78	44,295	***	***	***	***	***	375	146	93	***	47
09-05-78	45,635	170	44	***	***	6	389	***	***	***	50
09-06-78	43,980	151	23	***	***	5	393	112	174	52	45
09-07-78	21,503	95	47	***	***	18	262	118	122	61	65
09-08-78	44,607	***	***	***	***	***	***	***	***	***	***
09-09-78	17,899	***	***	***	***	***	***	***	***	***	***
09-10-78	40,054	***	***	***	***	***	618	***	***	***	45
09-11-78	38,107	***	***	***	***	***	429	109	103	44	42
09-12-78	41,972	149	***	***	***	5	389	***	***	***	41
09-13-78	43,688	136	21	***	***	5	383	91	88	42	35
09-14-78	44,660	139	***	***	***	6	387	***	***	***	37
09-15-78	45,898	***	***	***	***	***	***	***	***	***	***

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DATE	FLOW (gpd)	BOD,mg/l					COD,mg/l				
		I	A	N	F	E	I	A	N	F	E
09-16-78	45,395	***	***	***	***	***	***	***	***	***	***
09-17-78	45,207	***	***	***	***	***	336	***	***	***	44
09-18-78	45,805	***	***	***	***	***	456	129	82	45	36
09-19-78	22,350	245	***	***	***	7	677	***	***	***	44
09-20-78	32,455	269	49	***	***	15	753	152	122	63	54
09-21-78	45,790	164	***	***	***	6	430	***	***	***	42
09-22-78	45,540	***	***	***	***	***	***	***	***	***	***
09-23-78	45,810	***	***	***	***	***	***	***	***	***	***
09-24-78	17,915	***	***	***	***	***	295	***	***	***	41
09-25-78	24,465	***	***	***	***	***	288	77	87	62	60
09-26-78	36,263	100	***	***	***	20	295	***	***	***	66
09-27-78	14,652	***	33	***	***	***	248	157	109	58	51
09-28-78	45,402	160	***	***	***	6	439	***	***	***	47
09-29-78	42,293	***	***	***	***	***	***	***	***	***	***
09-30-78	39,440	***	***	***	***	***	***	***	***	***	***
10-01-78	39,450	***	***	***	***	***	361	***	***	***	36
10-02-78	41,250	***	***	***	***	***	353	86	129	99	64
10-03-78	42,588	273	***	***	***	19	680	***	***	***	60
10-04-78	13,127	392	15	***	***	15	1120	98	121	75	82
10-05-78	24,695	176	***	***	***	11	590	***	***	***	66
10-06-78	45,218	***	***	***	***	***	***	***	***	***	***
10-07-78	46,010	***	***	***	***	***	***	***	***	***	***

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DATE	FLOW (gpd)	BOD,mg/l					COD,mg/l				
		I	A	N	F	E	I	A	N	F	E
10-08-78	45,754	***	***	***	***	***	1470	***	***	***	114
10-09-78	45,823	***	***	***	***	***	627	123	123	82	63
10-10-78	45,372	165	***	***	***	18	378	***	***	***	68
10-11-78	46,113	162	36	***	***	12	496	102	117	50	53
10-12-78	44,915	213	***	***	***	5	426	***	***	***	44
10-13-78	38,725	***	***	***	***	***	***	***	***	***	***
10-14-78	27,010	***	***	***	***	***	***	***	***	***	***
10-15-78	37,580	***	***	***	***	***	254	***	***	***	32
10-16-78	40,380	***	***	***	***	***	275	102	104	86	47
10-17-78	41,110	93	***	***	***	13	369	***	***	***	58
10-18-78	39,475	95	22	***	***	11	315	109	138	65	55
10-19-78	39,360	115	***	***	***	8	330	***	***	***	51
10-20-78	39,665	***	***	***	***	***	***	***	***	***	***
10-21-78	41,779	***	***	***	***	***	***	***	***	***	***
10-22-78	42,688	***	***	***	***	***	345	***	***	***	49
10-23-78	43,573	***	***	***	***	***	460	137	121	61	52
10-24-78	45,447	159	***	***	***	8	469	***	***	***	56
10-25-78	45,273	141	13	***	***	6	399	***	***	***	54
10-26-78	44,745	133	***	***	***	7	404	88	76	53	48
10-27-78	44,925	108	42	24	***	5	326	110	75	46	41
10-28-78	44,570	196	29	***	9	8	657	96	81	49	29
10-29-78	45,379	183	62	29	***	9	451	147	90	62	48

BOD---BIOCHEMICAL OXYGEN DEMAND
COD---CHEMICAL OXYGEN DEMAND
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	FLOW (gpd)	BOD,mg/l (I	A	N	F	E)	COD,mg/l (I	A	N	F	E)
10-30-78	43,780	192	52	***	13	13	508	122	101	66	59
10-31-78	45,570	145	38	22	***	5	385	116	92	63	57
11-01-78	45,860	138	31	***	16	8	360	119	101	66	49
11-02-78	45,920	146	45	33	***	8	154	107	94	65	106
11-03-78	45,543	119	40	***	15	6	385	113	91	61	48
11-04-78	45,642	110	48	31	***	7	345	124	108	70	52
11-05-78	45,760	111	48	***	7	4	333	117	123	47	49
11-06-78	45,594	114	38	18	***	19	285	96	66	44	43

BOD---BIOCHEMICAL OXYGEN DEMAND
COD---CHEMICAL OXYGEN DEMAND
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TOC,mg/l					SS,mg/l					(VSS,mg/l)
	I	A	N	F	E	I	A	N	F	E	I
06-20-78	94.8	***	***	***	9.7	304	***	***	***	14	***
06-21-78	94.8	***	***	***	11.6	240	***	***	***	11	***
06-22-78	95.0	***	***	***	14.5	260	***	***	***	6	***
06-23-78	***	***	***	***	***	***	***	***	***	***	***
06-24-78	***	***	***	***	***	***	***	***	***	***	***
06-25-78	64.7	***	***	***	12.0	316	***	***	***	32	***
06-26-78	105.8	45.2	26.2	***	12.3	320	***	***	***	29	***
06-27-78	78.0	***	***	***	18.2	344	***	***	***	19	***
06-28-78	72.5	36.4	16.5	***	14.9	212	***	***	***	8	***
06-29-78	55.8	***	***	***	11.9	380	***	***	***	5	***
06-30-78	***	***	***	***	***	***	***	***	***	***	***
07-01-78	***	***	***	***	***	***	***	***	***	***	***
07-02-78	60.8	21.7	15.1	***	17.5	324	***	***	***	11	***
07-03-78	95.8	23.7	16.5	***	19.7	390	***	***	***	7	***
07-04-78	45.7	***	***	***	11.6	805	***	***	***	14	***
07-05-78	82.5	31.6	19.4	***	14.0	370	***	***	***	22	***
07-06-78	109.0	***	***	***	14.9	347	***	***	***	22	***
07-07-78	***	***	***	***	***	***	***	***	***	***	***
07-08-78	***	***	***	***	***	***	***	***	***	***	***
07-09-78	83.6	***	***	***	16.5	293	***	***	***	11	***
07-10-78	76.0	28.2	36.5	***	14.5	320	***	***	***	12	***
07-11-78	51.0	***	***	***	11.6	270	***	***	***	7	***

TOC---TOTAL ORGANIC CARBON
SS----SUSPENDED SOLIDS
VSS---VOLATILE SUSPENDED SOLIDS
I-----PLANT INFLUENT
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N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TOC,mg/l					SS,mg/l					VSS,mg/l	
	I	A	N	F	E	I	A	N	F	E	I	
07-12-78	62.0	31.1	57.0	***	13.6	265	***	***	***	6	***	
07-13-78	105.0	***	***	***	11.6	200	***	***	***	5	***	
07-14-78	***	***	***	***	***	***	***	***	***	***	***	
07-15-78	***	***	***	***	***	***	***	***	***	***	***	
07-16-78	103.0	***	***	***	15.9	305	***	***	***	10	***	
07-17-78	111.0	74.0	38.8	***	19.6	305	***	***	***	11	***	
07-18-78	304.0	***	***	***	20.4	820	***	***	***	7	***	
07-19-78	558.0	65.5	25.6	***	17.5	960	***	***	***	6	***	
07-20-78	94.3	***	***	***	14.5	280	***	***	***	7	***	
07-21-78	***	***	***	***	***	***	***	***	***	***	***	
07-22-78	***	***	***	***	***	***	***	***	***	***	***	
07-23-78	56.9	***	***	***	14.9	187	***	***	***	3	***	
07-24-78	50.9	30.3	33.6	***	12.7	335	***	***	***	12	***	
07-25-78	25.2	***	***	***	12.7	965	***	***	***	9	***	
07-26-78	52.7	35.8	19.8	***	10.9	573	***	***	***	9	267	
07-27-78	57.0	***	***	***	9.0	315	***	***	***	13	***	
07-28-78	***	***	***	***	***	***	***	***	***	***	***	
07-29-78	***	***	***	***	***	***	***	***	***	***	***	
07-30-78	48.1	***	***	***	11.2	640	***	***	***	14	260	
07-31-78	54.9	34.5	17.2	***	9.0	270	***	***	***	5	***	
08-01-78	38.1	***	***	***	12.7	230	***	***	***	5	***	
08-02-78	69.0	36.7	11.2	***	34.9	250	***	***	***	3	***	

TOC---TOTAL ORGANIC CARBON
SS----SUSPENDED SOLIDS
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I-----PLANT INFLUENT
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F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TOC,mg/l					SS,mg/l					VSS,mg/l
	I	A	N	F	E	I	A	N	F	E	I
08-03-78	63.0	***	***	***	15.4	420	***	***	***	7	245
08-04-78	***	***	***	***	***	***	***	***	***	***	***
08-05-78	***	***	***	***	***	***	***	***	***	***	***
08-06-78	61.9	***	***	***	12.3	185	***	***	***	1	***
08-07-78	78.7	30.6	34.9	***	26.3	230	***	***	***	23	***
08-08-78	59.7	***	***	***	17.4	280	***	***	***	17	***
08-09-78	67.0	40.8	21.8	***	16.7	265	***	***	***	22	***
08-10-78	47.6	***	***	***	13.8	220	***	***	***	9	***
08-11-78	***	***	***	***	***	***	***	***	***	***	***
08-12-78	***	***	***	***	***	***	***	***	***	***	***
08-13-78	97.7	***	***	***	9.4	225	***	***	***	4	***
08-14-78	67.3	33.5	13.1	***	7.2	104	***	***	***	4	***
08-15-78	86.0	***	***	***	12.3	420	***	***	***	6	255
08-16-78	75.8	26.2	20.7	***	14.5	225	***	***	***	6	***
08-17-78	59.9	***	***	***	12.1	144	***	***	***	6	***
08-18-78	***	***	***	***	***	***	***	***	***	***	***
08-19-78	***	***	***	***	***	***	***	***	***	***	***
08-20-78	51.9	***	***	***	10.3	285	***	***	***	9	***
08-21-78	90.9	30.0	18.2	***	13.1	270	***	***	***	4	***
08-22-78	80.6	***	***	***	11.6	265	***	***	***	6	***
08-23-78	95.8	27.7	28.4	***	11.6	240	***	***	***	6	***
08-24-78	45.2	***	***	***	11.6	64	***	***	***	7	***

TOC---TOTAL ORGANIC CARBON
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F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TOC,mg/l					SS,mg/l					VSS,mg/l
	I	A	N	F	E	I	A	N	F	E	I
08-25-78	***	***	***	***	***	***	***	***	***	***	***
08-26-78	***	***	***	***	***	***	***	***	***	***	***
08-27-78	47.2	***	***	***	11.8	195	***	***	***	2	***
08-28-78	106.0	46.1	20.2	***	11.2	250	***	***	***	2	***
08-29-78	88.8	***	***	***	18.0	330	***	***	***	5	***
08-30-78	106.0	42.1	26.1	***	16.3	210	***	***	***	4	***
08-31-78	74.7	***	***	***	13.5	130	***	***	***	4	***
09-01-78	***	***	***	***	***	***	***	***	***	***	***
09-02-78	***	***	***	***	***	***	***	***	***	***	***
09-03-78	52.6	***	***	***	14.6	195	***	***	***	1	***
09-04-78	109.0	47.2	18.5	***	16.8	195	***	***	***	3	***
09-05-78	115.0	***	***	***	12.1	175	82	***	***	3	***
09-06-78	144.0	39.3	40.2	15.5	15.7	200	50	***	***	3	***
09-07-78	63.4	43.6	16.8	14.6	18.0	128	60	***	***	8	***
09-08-78	***	***	***	***	***	***	***	***	***	***	***
09-09-78	***	***	***	***	***	***	***	***	***	***	***
09-10-78	193.0	***	***	***	11.4	405	***	***	***	10	275
09-11-78	110.0	37.1	15.1	16.8	13.5	295	***	***	***	2	***
09-12-78	79.5	***	***	***	12.9	190	***	***	***	1	***
09-13-78	98.3	30.9	17.4	10.6	17.4	225	13	***	***	2	***
09-14-78	123.0	***	***	***	15.1	275	***	***	***	3	***
09-15-78	***	***	***	***	***	***	***	***	***	***	***

TOC---TOTAL ORGANIC CARBON
SS----SUSPENDED SOLIDS
VSS---VOLATILE SUSPENDED SOLIDS
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F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TOC,mg/l					SS,mg/l					(VSS,mg/l)
	(I	A	N	F	E)	(I	A	N	F	E)	(I)
09-16-78	***	***	***	***	***	***	***	***	***	***	***
09-17-78	80.1	***	***	***	10.3	115	***	***	***	5	***
09-18-78	162.0	52.8	14.0	13.8	9.5	195	***	***	***	4	***
09-19-78	248.0	***	***	***	10.6	350	***	***	***	3	***
09-20-78	142.0	51.2	27.0	32.8	13.5	555	82	***	***	6	440
09-21-78	136.0	***	***	***	20.4	295	***	***	***	9	***
09-22-78	***	***	***	***	***	***	***	***	***	***	***
09-23-78	***	***	***	***	***	***	***	***	***	***	***
09-24-78	75.3	***	***	***	10.1	175	***	***	***	3	***
09-25-78	72.0	24.7	14.0	12.5	14.0	184	***	***	***	5	***
09-26-78	83.4	***	***	***	20.2	215	***	***	***	7	***
09-27-78	63.2	30.3	24.1	14.0	11.2	***	34	***	***	***	***
09-28-78	151.0	***	***	***	10.1	275	***	***	***	3	***
09-29-78	***	***	***	***	***	***	***	***	***	***	***
09-30-78	***	***	***	***	***	***	***	***	***	***	***
10-01-78	134.0	***	***	***	9.9	195	***	***	***	2	***
10-02-78	104.0	22.5	25.6	24.1	18.0	485	***	***	***	10	170
10-03-78	385.0	***	***	***	12.3	685	***	***	***	6	395
10-04-78	346.0	27.5	37.1	22.5	20.2	2370	126	***	***	16	810
10-05-78	137.0	***	***	***	19.1	500	***	***	***	5	270
10-06-78	***	***	***	***	***	***	***	***	***	***	***
10-07-78	***	***	***	***	***	***	***	***	***	***	***

TOC---TOTAL ORGANIC CARBON
SS----SUSPENDED SOLIDS
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I-----PLANT INFLUENT
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E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TOC,mg/l					SS,mg/l					(VSS,mg/l)
	(I	A	N	F	E)	(I	A	N	F	E)	(I)
10-08-78	346.0	***	***	***	20.2	2620	***	***	***	10	800
10-09-78	115.0	43.8	20.2	25.8	16.3	635	***	***	***	6	375
10-10-78	173.0	***	***	***	18.0	410	***	***	***	11	315
10-11-78	108.0	32.0	16.8	7.8	16.8	285	66	***	***	7	***
10-12-78	180.0	***	***	***	10.1	***	***	***	***	***	***
10-13-78	***	***	***	***	***	***	***	***	***	***	***
10-14-78	***	***	***	***	***	***	***	***	***	***	***
10-15-78	68.4	***	***	***	11.5	1210	***	***	***	25	140
10-16-78	74.0	35.6	18.8	28.6	16.8	415	***	***	***	12	160
10-17-78	99.3	***	***	***	20.8	335	***	***	***	14	***
10-18-78	84.7	38.0	25.0	21.6	19.7	330	82	***	***	18	***
10-19-78	88.9	***	***	***	19.7	240	***	***	***	3	***
10-20-78	***	***	***	***	***	***	***	***	***	***	***
10-21-78	***	***	***	***	***	***	***	***	***	***	***
10-22-78	92.9	***	***	***	17.5	330	***	***	***	8	220
10-23-78	124.0	47.8	21.9	20.2	18.6	325	***	***	***	8	***
10-24-78	126.0	***	***	***	20.0	335	***	***	***	7	***
10-25-78	108.0	***	***	***	19.4	350	78	***	***	11	***
10-26-78	109.0	30.7	13.7	17.6	17.2	305	***	***	***	12	***
10-27-78	102.0	37.4	10.9	17.5	10.3	290	44	30	25	7	***
10-28-78	205.0	32.6	11.8	18.7	7.3	480	13	58	15	9	440
10-29-78	140.0	50.0	19.9	23.6	15.4	360	20	42	14	15	330

TOC---TOTAL ORGANIC CARBON
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I-----PLANT INFLUENT
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F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

BEGIN LAST LINE OF TEXT
EPA-2B7 (Cin.) (4-76)
3/8"
PAGE NUMBER
BOTTOM OF IMAGE AREA, OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
BEGIN FIRST LINE OF TEXT HERE
DROPPED HEAD, BEGIN SECTIONS HERE
TYPING GUIDE SHEET
CENTER OF PAGE
TOP OF IMAGE AREA

DATE	TOC,mg/l					SS,mg/l				(VSS,mg/l)
	(I	A	N	F	E)	(I	A	N	F	E) (I)
10-30-78	158.0	42.6	22.3	25.1	21.1	355	18	48	12	8 290
10-31-78	120.0	39.4	18.2	24.0	14.4	265	9	42	13	6 ***
11-01-78	112.0	40.5	25.1	25.1	12.4	240	48	46	15	6 ***
11-02-78	48.0	37.3	20.8	24.8	38.0	385	16	64	10	11 235
11-03-78	120.0	39.4	20.1	23.2	17.2	250	14	50	11	8 ***
11-04-78	107.0	43.3	23.9	26.7	18.6	210	48	48	13	4 ***
11-05-78	104.0	40.8	27.2	17.9	17.5	160	5	32	7	6 ***
11-06-78	89.0	33.5	14.6	16.7	15.4	85	1	22	3	3 ***

TOC---TOTAL ORGANIC CARBON
SS----SUSPENDED SOLIDS
VSS---VOLATILE SUSPENDED SOLIDS
I-----PLANT INFLUENT
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F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TKN,mg/l					NH3-N,mg/l				
	I	A	N	F	E	I	A	N	F	E
06-20-78	36.0	***	***	***	29.2	19.1	***	***	***	26.3
06-21-78	30.7	***	***	***	21.0	11.6	***	***	***	16.9
06-22-78	33.8	***	***	***	23.2	15.7	***	***	***	21.3
06-23-78	***	***	***	***	***	***	***	***	***	***
06-24-78	***	***	***	***	***	***	***	***	***	***
06-25-78	31.0	***	***	***	31.0	20.8	***	***	***	26.3
06-26-78	37.2	28.3	29.2	***	29.2	19.0	18.2	21.6	***	25.5
06-27-78	34.3	***	***	***	25.3	15.3	***	***	***	21.3
06-28-78	35.2	32.3	32.0	***	24.2	20.0	22.9	25.4	***	22.1
06-29-78	40.0	***	***	***	30.8	19.2	***	***	***	23.3
06-30-78	***	***	***	***	***	***	***	***	***	***
07-01-78	***	***	***	***	***	***	***	***	***	***
07-02-78	36.7	25.0	25.4	***	31.9	23.8	19.9	22.5	***	28.0
07-03-78	26.2	24.6	32.2	***	28.0	20.4	18.2	19.8	***	23.7
07-04-78	30.0	***	***	***	28.7	17.0	***	***	***	20.2
07-05-78	23.3	27.2	31.3	***	38.8	21.1	23.0	23.7	***	24.6
07-06-78	32.8	***	***	***	27.4	18.8	***	***	***	23.5
07-07-78	***	***	***	***	***	***	***	***	***	***
07-08-78	***	***	***	***	***	***	***	***	***	***
07-09-78	38.5	***	***	***	31.7	25.0	***	***	***	30.5
07-10-78	38.0	36.8	35.0	***	33.0	25.3	31.6	30.0	***	31.7
07-11-78	38.5	***	***	***	30.8	21.6	***	***	***	27.9

TKN---TOTAL KJELDAHL NITROGEN
NH_3-N-AMMONIA NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TKN,mg/l					NH3-N,mg/l				
	I	A	N	F	E	I	A	N	F	E
07-12-78	38.1	38.7	39.8	***	30.8	21.8	29.0	28.3	***	27.3
07-13-78	39.1	***	***	***	31.0	23.0	***	***	***	27.3
07-14-78	***	***	***	***	***	***	***	***	***	***
07-15-78	***	***	***	***	***	***	***	***	***	***
07-16-78	43.3	***	***	***	33.7	25.9	***	***	***	29.7
07-17-78	45.4	44.4	39.6	***	34.7	27.8	31.4	31.4	***	32.2
07-18-78	98.8	***	***	***	32.3	76.4	***	***	***	28.9
07-19-78	119.0	43.5	37.5	***	33.0	50.8	31.0	31.9	***	27.6
07-20-78	62.4	***	***	***	49.3	23.9	***	***	***	29.0
07-21-78	***	***	***	***	***	***	***	***	***	***
07-22-78	***	***	***	***	***	***	***	***	***	***
07-23-78	37.8	***	***	***	35.3	26.9	***	***	***	34.7
07-24-78	36.8	32.8	32.5	***	30.3	22.7	24.8	25.7	***	28.2
07-25-78	32.0	***	***	***	25.5	18.5	***	***	***	24.0
07-26-78	32.7	32.8	30.5	***	23.2	18.3	22.3	25.9	***	21.9
07-27-78	33.3	***	***	***	23.5	17.1	***	***	***	20.5
07-28-78	***	***	***	***	***	***	***	***	***	***
07-29-78	***	***	***	***	***	***	***	***	***	***
07-30-78	32.7	***	***	***	23.6	17.3	***	***	***	22.8
07-31-78	31.5	25.0	27.2	***	24.0	20.1	20.1	22.8	***	22.6
08-01-78	28.8	***	***	***	19.8	15.4	***	***	***	17.3
08-02-78	31.2	31.5	28.7	***	20.3	15.9	21.0	21.6	***	16.6

TKN---TOTAL KJELDAHL NITROGEN
NH_3-N-AMMONIA NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

BEGIN LAST LINE OF TEXT
3/8"
PAGE NUMBER
52
EPA-257 (Cin.) (4-76)
BOTTOM OF IMAGE AREA. OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
BEGIN FIRST LINE OF TEXT HERE
DROPPED HEAD. BEGIN SECTIONS HERE
TYPING GUIDE SHEET
CENTER OF PAGE
TOP OF IMAGE AREA

DATE	TKN,mg/l					NH3-N,mg/l				
	I	A	N	F	E	I	A	N	F	E
08-03-78	32.8	***	***	***	20.2	15.9	***	***	***	16.2
08-04-78	***	***	***	***	***	***	***	***	***	***
08-05-78	***	***	***	***	***	***	***	***	***	***
08-06-78	33.0	***	***	***	25.2	17.0	***	***	***	18.9
08-07-78	40.2	35.5	39.2	***	32.0	19.9	26.9	26.2	***	18.2
08-08-78	36.5	***	***	***	29.8	22.0	***	***	***	23.5
08-09-78	30.0	36.5	33.7	***	23.7	17.4	22.7	23.7	***	19.9
08-10-78	35.6	***	***	***	30.2	20.2	***	***	***	25.0
08-11-78	***	***	***	***	***	***	***	***	***	***
08-12-78	***	***	***	***	***	***	***	***	***	***
08-13-78	34.7	***	***	***	27.3	21.4	***	***	***	23.9
08-14-78	34.1	36.1	34.8	***	29.7	23.6	30.5	30.2	***	27.4
08-15-78	41.3	***	***	***	28.6	22.2	***	***	***	26.3
08-16-78	35.6	34.3	37.0	***	28.8	20.7	29.1	30.8	***	26.3
08-17-78	34.9	***	***	***	30.1	24.3	***	***	***	28.1
08-18-78	***	***	***	***	***	***	***	***	***	***
08-19-78	***	***	***	***	***	***	***	***	***	***
08-20-78	38.4	***	***	***	29.3	23.1	***	***	***	26.8
08-21-78	41.8	35.5	34.5	***	32.5	25.5	28.3	31.0	***	31.5
08-22-78	43.7	***	***	***	28.0	19.5	***	***	***	25.5
08-23-78	38.0	36.9	42.3	***	28.8	20.6	28.5	29.8	***	26.7
08-24-78	33.6	***	***	***	32.7	25.0	***	***	***	30.9

TKN---TOTAL KJELDAHL NITROGEN
NH_3-N-AMMONIA NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TKN,mg/l					NH3-N,mg/l				
	I	A	N	F	E	I	A	N	F	E
08-25-78	***	***	***	***	***	***	***	***	***	***
08-26-78	***	***	***	***	***	***	***	***	***	***
08-27-78	29.4	***	***	***	29.0	23.2	***	***	***	28.2
08-28-78	26.9	38.9	37.1	***	32.2	26.2	30.4	32.2	***	30.9
08-29-78	37.1	***	***	***	28.6	19.7	***	***	***	26.5
08-30-78	36.6	35.7	37.2	***	25.4	20.7	27.6	31.6	***	23.5
08-31-78	28.8	***	***	***	24.1	17.2	***	***	***	22.6
09-01-78	***	***	***	***	***	***	***	***	***	***
09-02-78	***	***	***	***	***	***	***	***	***	***
09-03-78	36.2	***	***	***	24.7	21.4	***	***	***	23.1
09-04-78	36.4	35.4	36.6	***	24.7	21.6	31.2	32.6	***	22.6
09-05-78	38.9	***	***	***	26.0	23.9	***	***	***	25.0
09-06-78	33.7	27.1	36.5	24.8	24.1	21.1	21.7	23.8	23.3	22.4
09-07-78	27.2	36.0	55.2	26.0	26.8	18.8	26.2	25.0	23.3	22.5
09-08-78	***	***	***	***	***	***	***	***	***	***
09-09-78	***	***	***	***	***	***	***	***	***	***
09-10-78	36.8	***	***	***	21.4	16.9	***	***	***	18.3
09-11-78	38.1	31.4	30.6	26.0	24.8	23.2	26.0	24.6	24.5	22.6
09-12-78	32.9	***	***	***	19.9	20.6	***	***	***	19.0
09-13-78	29.5	31.6	31.1	26.0	19.4	20.8	27.6	25.6	24.2	18.5
09-14-78	38.1	***	***	***	18.9	20.6	***	***	***	17.7
09-15-78	***	***	***	***	***	***	***	***	***	***

TKN---TOTAL KJELDAHL NITROGEN
NH_3-N-AMMONIA NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

BEGIN FIRST LINE OF TEXT HERE
TYPING GUIDE SHEET
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD: BEGIN SECTIONS HERE
9-1/8"
BEGIN LAST LINE OF TEXT
3/8"
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
EPA-287 (Cin.) (4-76)
PAGE NUMBER

DATE	TKN,mg/l					NH3-N,mg/l				
	I	A	N	F	E	I	A	N	F	E
09-16-78	***	***	***	***	***	***	***	***	***	***
09-17-78	34.3	***	***	***	23.1	22.8	***	***	***	21.1
09-18-78	35.2	36.5	27.3	27.9	20.0	22.8	30.4	22.5	25.6	18.2
09-19-78	33.9	***	***	***	24.2	22.3	***	***	***	22.4
09-20-78	40.3	40.4	37.2	31.0	22.3	22.6	29.8	28.4	28.4	19.8
09-21-78	56.6	***	***	***	34.9	22.9	***	***	***	21.4
09-22-78	***	***	***	***	***	***	***	***	***	***
09-23-78	***	***	***	***	***	***	***	***	***	***
09-24-78	27.4	***	***	***	22.2	21.8	***	***	***	19.9
09-25-78	28.4	18.7	16.6	12.3	24.9	14.2	13.0	10.1	8.4	14.2
09-26-78	28.0	***	***	***	16.4	14.6	***	***	***	8.5
09-27-78	35.1	28.2	24.4	23.5	26.8	21.2	22.6	21.4	20.7	24.2
09-28-78	33.1	***	***	***	17.0	17.0	***	***	***	15.2
09-29-78	***	***	***	***	***	***	***	***	***	***
09-30-78	***	***	***	***	***	***	***	***	***	***
10-01-78	36.4	***	***	***	22.7	24.4	***	***	***	22.3
10-02-78	44.6	33.3	34.8	32.4	24.6	24.9	25.6	29.2	23.8	20.6
10-03-78	49.1	***	***	***	22.1	20.6	***	***	***	19.0
10-04-78	67.3	24.9	26.8	23.4	30.4	21.0	20.0	20.2	19.8	24.7
10-05-78	36.1	***	***	***	19.8	15.7	***	***	***	16.5
10-06-78	***	***	***	***	***	***	***	***	***	***
10-07-78	***	***	***	***	***	***	***	***	***	***

TKN---TOTAL KJELDAHL NITROGEN
NH_3-N-AMMONIA NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TKN,mg/l					NH3-N,mg/l				
	I	A	N	F	E	I	A	N	F	E
10-08-78	69.9	***	***	***	30.6	20.4	***	***	***	22.2
10-09-78	51.8	30.9	29.7	27.8	24.8	21.1	22.5	22.0	22.3	22.0
10-10-78	38.3	***	***	***	20.9	19.0	***	***	***	17.7
10-11-78	34.2	29.2	28.0	25.0	19.3	16.9	22.8	22.6	22.5	17.1
10-12-78	32.9	***	***	***	18.2	15.5	***	***	***	16.4
10-13-78	***	***	***	***	***	***	***	***	***	***
10-14-78	***	***	***	***	***	***	***	***	***	***
10-15-78	20.5	***	***	***	11.7	10.8	***	***	***	9.6
10-16-78	37.5	28.2	29.9	25.6	17.5	16.5	20.3	22.7	19.5	14.4
10-17-78	29.3	***	***	***	17.2	15.3	***	***	***	14.8
10-18-78	26.4	28.7	32.2	24.3	16.5	16.1	21.3	24.6	20.4	14.6
10-19-78	34.6	***	***	***	20.0	18.4	***	***	***	18.3
10-20-78	***	***	***	***	***	***	***	***	***	***
10-21-78	***	***	***	***	***	***	***	***	***	***
10-22-78	43.0	***	***	***	24.7	22.1	***	***	***	22.2
10-23-78	41.4	35.6	33.6	30.0	23.9	21.1	25.0	25.7	26.5	21.9
10-24-78	34.6	***	***	***	24.3	17.6	***	***	***	19.1
10-25-78	38.9	***	***	***	25.5	19.2	***	***	***	20.8
10-26-78	38.0	27.4	24.0	24.1	23.2	20.9	22.9	21.1	22.0	21.7
10-27-78	28.6	29.0	26.0	25.6	19.1	16.3	22.9	22.8	23.2	16.8
10-28-78	34.2	28.8	28.7	28.3	21.1	18.0	23.9	25.0	25.5	18.9
10-29-78	39.1	36.5	34.8	33.5	24.2	20.0	27.6	29.0	29.6	21.5

TKN---TOTAL KJELDAHL NITROGEN
NH_3-N-AMMONIA NITROGEN
I-----PLANT INFLUENT
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N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TKN,mg/l					NH3-N,mg/l				
	I	A	N	F	E	I	A	N	F	E
10-30-78	41.9	38.9	33.7	32.8	27.5	29.3	30.1	29.4	29.4	23.6
10-31-78	36.4	31.1	28.2	26.9	22.7	18.7	23.2	23.0	23.9	20.9
11-01-78	31.5	32.8	29.9	29.0	21.4	18.0	23.9	24.9	24.9	18.2
11-02-78	32.3	29.5	28.1	26.1	20.8	16.8	22.6	23.0	23.1	17.7
11-03-78	31.1	28.4	26.9	25.6	18.7	16.3	23.1	22.4	22.5	16.7
11-04-78	37.1	29.7	25.2	23.9	20.5	17.3	20.0	20.3	19.1	17.9
11-05-78	35.5	30.4	23.5	23.8	22.7	20.5	22.5	20.2	21.0	20.5
11-06-78	36.0	38.3	33.3	30.8	25.8	25.6	31.7	28.8	28.4	22.2

TKN---TOTAL KJELDAHL NITROGEN
NH_3-N-AMMONIA NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	NO_2-N, mg/l					NO_3-N, mg/l				
	I	A	N	F	E	I	A	N	F	E
06-20-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	<0.1
06-21-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	0.2
06-22-78	<0.1	***	***	***	<0.1	0.2	***	***	***	0.2
06-23-78	***	***	***	***	***	***	***	***	***	***
06-24-78	***	***	***	***	***	***	***	***	***	***
06-25-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	0.1
06-26-78	<0.1	<0.1	<0.1	***	<0.1	0.1	0.2	0.2	***	0.1
06-27-78	0.2	***	***	***	<0.1	0.1	***	***	***	<0.1
06-28-78	<0.1	<0.1	<0.1	***	<0.1	0.2	<0.1	0.1	***	<0.1
06-29-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	<0.1
06-30-78	***	***	***	***	***	***	***	***	***	***
07-01-78	***	***	***	***	***	***	***	***	***	***
07-02-78	0.2	<0.1	0.3	***	<0.1	<0.1	0.2	0.1	***	<0.1
07-03-78	<0.1	<0.1	0.2	***	<0.1	<0.1	0.1	0.2	***	<0.1
07-04-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	<0.1
07-05-78	<0.1	<0.1	0.1	***	<0.1	<0.1	<0.1	0.1	***	<0.1
07-06-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	<0.1
07-07-78	***	***	***	***	***	***	***	***	***	***
07-08-78	***	***	***	***	***	***	***	***	***	***
07-09-78	0.1	***	***	***	0.2	<0.1	***	***	***	0.2
07-10-78	<0.1	0.4	<0.1	***	<0.1	<0.1	0.2	<0.1	***	<0.1
07-11-78	0.2	***	***	***	<0.1	0.2	***	***	***	<0.1

NO_2-N-NITRITE NITROGEN
NO_3-N-NITRATE NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	(NO_2-N, mg/l					)	(NO_3-N, mg/l					)
	(I	A	N	F	E	)	(I	A	N	F	E	)
07-12-78	0.2	0.2	<0.1	***	<0.1		0.1	0.3	0.1	***	0.1	
07-13-78	0.1	***	***	***	<0.1		0.1	***	***	***	<0.1	
07-14-78	***	***	***	***	***		***	***	***	***	***	
07-15-78	***	***	***	***	***		***	***	***	***	***	
07-16-78	<0.1	***	***	***	<0.1		0.1	***	***	***	<0.1	
07-17-78	0.2	<0.1	0.5	***	<0.1		0.1	<0.1	0.2	***	0.1	
07-18-78	<0.1	***	***	***	<0.1		0.1	***	***	***	0.1	
07-19-78	<0.1	<0.1	0.8	***	<0.1		0.1	0.1	0.4	***	0.1	
07-20-78	<0.1	***	***	***	<0.1		0.1	***	***	***	0.1	
07-21-78	***	***	***	***	***		***	***	***	***	***	
07-22-78	***	***	***	***	***		***	***	***	***	***	
07-23-78	0.2	***	***	***	<0.1		0.2	***	***	***	<0.1	
07-24-78	0.2	<0.1	0.8	***	<0.1		0.2	<0.1	0.8	***	<0.1	
07-25-78	0.2	***	***	***	<0.1		0.2	***	***	***	<0.1	
07-26-78	0.2	0.1	0.8	***	0.2		0.2	0.2	0.6	***	<0.1	
07-27-78	0.2	***	***	***	0.3		0.2	***	***	***	<0.1	
07-28-78	***	***	***	***	***		***	***	***	***	***	
07-29-78	***	***	***	***	***		***	***	***	***	***	
07-30-78	0.4	***	***	***	0.2		0.3	***	***	***	<0.1	
07-31-78	0.4	0.3	1.7	***	0.9		0.3	0.2	0.6	***	0.2	
08-01-78	0.3	***	***	***	1.0		0.3	***	***	***	0.6	
08-02-78	0.2	0.3	1.7	***	1.1		0.2	0.2	2.3	***	0.8	

NO_2-N-NITRITE NITROGEN
NO_3-N-NITRATE NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	(NO_2-N,mg/l				)	(NO_3-N,mg/l				)
	(I	A	N	F	E)	(I	A	N	F	E)
08-03-78	0.1	***	***	***	1.2	0.2	***	***	***	0.9
08-04-78	***	***	***	***	***	***	***	***	***	***
08-05-78	***	***	***	***	***	***	***	***	***	***
08-06-78	0.2	***	***	***	0.4	0.3	***	***	***	0.1
08-07-78	0.1	<0.1	0.1	***	<0.1	0.3	<0.1	0.2	***	0.1
08-08-78	<0.1	***	***	***	0.1	0.2	***	***	***	<0.1
08-09-78	<0.1	<0.1	0.1	***	0.1	0.2	<0.1	<0.1	***	<0.1
08-10-78	<0.1	***	***	***	<0.1	0.3	***	***	***	<0.1
08-11-78	***	***	***	***	***	***	***	***	***	***
08-12-78	***	***	***	***	***	***	***	***	***	***
08-13-78	<0.1	***	***	***	<0.1	0.3	***	***	***	<0.1
08-14-78	<0.1	<0.1	<0.1	***	<0.1	0.3	<0.1	0.2	***	<0.1
08-15-78	<0.1	***	***	***	<0.1	0.1	***	***	***	0.1
08-16-78	<0.1	<0.1	<0.1	***	<0.1	0.3	<0.1	0.2	***	0.1
08-17-78	<0.1	***	***	***	<0.1	0.3	***	***	***	0.1
08-18-78	***	***	***	***	***	***	***	***	***	***
08-19-78	***	***	***	***	***	***	***	***	***	***
08-20-78	<0.1	***	***	***	0.1	0.3	***	***	***	<0.1
08-21-78	<0.1	<0.1	0.2	***	<0.1	0.3	<0.1	0.2	***	0.1
08-22-78	<0.1	***	***	***	<0.1	0.3	***	***	***	0.1
08-23-78	<0.1	<0.1	0.6	***	<0.1	<0.1	<0.1	0.1	***	0.1
08-24-78	<0.1	***	***	***	<0.1	0.3	***	***	***	<0.1

NO_2-N-NITRITE NITROGEN
NO_3-N-NITRATE NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

BEGIN LAST LINE OF TEXT
3/8"
EPA-287 (Cin.) (4-76)
PAGE NUMBER
60
BOTTOM OF IMAGE AREA. OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
9-1/8"
BEGIN FIRST LINE OF TEXT HERE
DROPPED HEAD: BEGIN SECTIONS HERE
TYPING GUIDE SHEET
CENTER OF PAGE
TOP OF IMAGE AREA

BEGIN FIRST LINE OF TEXT HERE
TYPING GUIDE SHEET
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD; BEGIN SECTIONS HERE
9 1/8"
BEGIN LAST LINE OF TEXT
3/8"
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS

DATE	NO_2-N, mg/l					NO_3-N, mg/l				
	I	A	N	F	E	I	A	N	F	E
08-25-78	***	***	***	***	***	***	***	***	***	***
08-26-78	***	***	***	***	***	***	***	***	***	***
08-27-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	<0.1
08-28-78	<0.1	<0.1	0.5	***	<0.1	<0.1	<0.1	0.5	***	<0.1
08-29-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	<0.1
08-30-78	<0.1	<0.1	0.6	***	<0.1	<0.1	<0.1	1.1	***	<0.1
08-31-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	<0.1
09-01-78	***	***	***	***	***	***	***	***	***	***
09-02-78	***	***	***	***	***	***	***	***	***	***
09-03-78	<0.1	***	***	***	0.7	<0.1	***	***	***	0.3
09-04-78	<0.1	<0.1	1.2	***	0.8	<0.1	<0.1	1.0	***	0.3
09-05-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	<0.1
09-06-78	<0.1	<0.1	1.1	1.2	0.6	<0.1	0.1	1.5	1.9	0.4
09-07-78	<0.1	<0.1	1.2	1.3	0.5	0.3	0.1	1.9	1.8	0.3
09-08-78	***	***	***	***	***	***	***	***	***	***
09-09-78	***	***	***	***	***	***	***	***	***	***
09-10-78	<0.1	***	***	***	0.5	0.2	***	***	***	0.4
09-11-78	<0.1	<0.1	1.6	1.8	0.4	0.3	<0.1	1.8	1.9	0.2
09-12-78	<0.1	***	***	***	0.6	<0.1	***	***	***	0.8
09-13-78	<0.1	<0.1	1.1	1.1	0.8	<0.1	<0.1	0.3	1.9	1.4
09-14-78	<0.1	***	***	***	0.9	<0.1	***	***	***	0.6
09-15-78	***	***	***	***	***	***	***	***	***	***

NO_2-N-NITRITE NITROGEN
NO_3-N-NITRATE NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***--UNDEFINED DATA

EPA-287 (Cin.)
(4-76)

DATE	(NO_2-N,mg/l				)	(NO_3-N,mg/l				)
	(I	A	N	F	E)	(I	A	N	F	E)
09-16-78	***	***	***	***	***	***	***	***	***	***
09-17-78	<0.1	***	***	***	0.5	0.3	***	***	***	0.3
09-18-78	<0.1	<0.1	1.3	1.3	1.0	0.3	0.1	3.1	3.0	1.4
09-19-78	<0.1	***	***	***	1.2	0.1	***	***	***	1.3
09-20-78	<0.1	<0.1	1.2	1.2	0.8	<0.1	<0.1	1.8	2.0	0.3
09-21-78	<0.1	***	***	***	1.1	<0.1	***	***	***	0.9
09-22-78	***	***	***	***	***	***	***	***	***	***
09-23-78	***	***	***	***	***	***	***	***	***	***
09-24-78	0.3	***	***	***	0.6	0.6	***	***	***	3.4
09-25-78	0.3	0.2	0.2	0.3	0.4	0.9	0.8	4.1	4.3	1.8
09-26-78	0.2	***	***	***	0.1	0.5	***	***	***	0.3
09-27-78	<0.1	<0.1	0.2	0.5	0.2	<0.1	<0.1	0.8	1.2	0.3
09-28-78	<0.1	***	***	***	0.1	<0.1	***	***	***	0.2
09-29-78	***	***	***	***	***	***	***	***	***	***
09-30-78	***	***	***	***	***	***	***	***	***	***
10-01-78	<0.1	***	***	***	0.1	<0.1	***	***	***	0.2
10-02-78	<0.1	<0.1	0.8	0.7	0.2	0.2	0.1	0.5	0.5	<0.1
10-03-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	<0.1
10-04-78	<0.1	0.6	0.9	0.9	0.1	<0.1	0.4	1.8	1.8	0.1
10-05-78	0.2	***	***	***	0.8	0.5	***	***	***	0.4
10-06-78	***	***	***	***	***	***	***	***	***	***
10-07-78	***	***	***	***	***	***	***	***	***	***

NO_2-N-NITRITE NITROGEN
NO_3-N-NITRATE NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	(NO_2-N,mg/l				)	(NO_3-N,mg/l				)
	(I	A	N	F	E)	(I	A	N	F	E)
10-08-78	<0.1	***	***	***	<0.1	<0.1	***	***	***	0.2
10-09-78	<0.1	<0.1	0.4	0.4	0.2	0.1	0.1	0.8	0.7	0.1
10-10-78	<0.1	***	***	***	0.1	<0.1	***	***	***	0.1
10-11-78	<0.1	<0.1	0.2	0.3	0.3	<0.1	<0.1	0.7	0.6	<0.1
10-12-78	<0.1	***	***	***	0.1	0.2	***	***	***	0.1
10-13-78	***	***	***	***	***	***	***	***	***	***
10-14-78	***	***	***	***	***	***	***	***	***	***
10-15-78	0.4	***	***	***	0.8	0.6	***	***	***	1.4
10-16-78	0.3	0.4	0.8	0.8	0.9	0.6	0.1	1.0	1.0	0.8
10-17-78	0.5	***	***	***	1.4	0.3	***	***	***	0.4
10-18-78	0.6	0.6	1.5	1.5	1.5	0.3	<0.1	1.0	0.9	0.3
10-19-78	0.6	***	***	***	0.9	0.3	***	***	***	<0.1
10-20-78	***	***	***	***	***	***	***	***	***	***
10-21-78	***	***	***	***	***	***	***	***	***	***
10-22-78	0.5	***	***	***	0.9	0.2	***	***	***	<0.1
10-23-78	0.5	0.3	1.3	1.4	0.8	0.3	<0.1	0.6	0.7	<0.1
10-24-78	<0.1	***	***	***	0.9	0.5	***	***	***	<0.1
10-25-78	<0.1	***	***	***	0.4	0.4	***	***	***	<0.1
10-26-78	0.6	<0.1	1.4	1.4	0.6	<0.1	0.1	0.6	0.6	<0.1
10-27-78	0.6	0.5	0.7	0.7	0.7	0.1	<0.1	1.0	1.1	0.2
10-28-78	0.7	0.6	0.7	0.7	0.5	<0.1	<0.1	0.4	0.4	<0.1
10-29-78	0.5	0.5	0.7	0.7	0.6	<0.1	<0.1	1.0	1.0	<0.1

NO_2-N-NITRITE NITROGEN
NO_3-N-NITRATE NITROGEN
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

BEGIN FIRST LINE OF TEXT HERE
TYPING GUIDE SHEET
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD: BEGIN SECTIONS HERE

DATE	NO_2-N, mg/l					NO_3-N, mg/l				
	(I	A	N	F	E)	(I	A	N	F	E)
10-30-78	0.5	0.5	0.8	0.8	0.6	<0.1	<0.1	1.4	1.4	<0.1
10-31-78	0.5	0.5	0.8	0.1	0.7	<0.1	<0.1	1.3	1.2	<0.1
11-01-78	0.5	0.5	0.9	0.9	0.7	0.2	<0.1	1.2	1.4	0.1
11-02-78	0.5	0.5	0.8	0.9	0.7	<0.1	<0.1	1.2	1.3	<0.1
11-03-78	0.6	0.5	0.9	0.9	0.8	<0.1	<0.1	1.5	1.5	<0.1
11-04-78	0.5	0.5	0.9	0.9	0.8	<0.1	<0.1	1.5	0.9	0.2
11-05-78	0.5	0.5	0.9	0.9	0.7	<0.1	<0.1	1.2	1.2	0.1
11-06-78	0.5	0.5	1.0	1.0	0.7	0.3	<0.1	1.6	1.9	0.4

9-1/8"

NO_2-N-NITRITE NITROGEN
NO_3-N-NITRATE NITROGEN
I------PLANT INFLUENT
A------CLARIFIER EFFLUENT
N------NITRIFICATION TOWER EFFLUENT
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E------PLANT EFFLUENT
***--UNDEFINED DATA

BEGIN LAST LINE OF TEXT
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

PAGE NUMBER
EPA-287 (Cin.) (4-76)

DATE	T-P,mg/l					O-P,mg/l				
	I	A	N	F	E	I	A	N	F	E
06-20-78	10.8	***	***	***	1.7	6.9	***	***	***	1.5
06-21-78	10.7	***	***	***	2.8	6.0	***	***	***	2.6
06-22-78	11.3	***	***	***	2.4	6.2	***	***	***	2.3
06-23-78	***	***	***	***	***	***	***	***	***	***
06-24-78	***	***	***	***	***	***	***	***	***	***
06-25-78	11.4	***	***	***	6.2	10.4	***	***	***	5.1
06-26-78	11.1	5.7	3.0	***	7.6	10.1	4.2	2.3	***	4.9
06-27-78	9.8	***	***	***	3.3	6.4	***	***	***	3.2
06-28-78	***	2.0	2.1	***	2.6	***	1.2	1.6	***	2.5
06-29-78	12.8	***	***	***	1.9	8.8	***	***	***	1.7
06-30-78	***	***	***	***	***	***	***	***	***	***
07-01-78	***	***	***	***	***	***	***	***	***	***
07-02-78	8.5	1.8	2.4	***	2.2	6.5	1.4	1.9	***	2.0
07-03-78	11.3	3.8	3.5	***	2.7	8.8	2.8	3.1	***	2.5
07-04-78	13.6	***	***	***	2.3	10.5	***	***	***	2.3
07-05-78	9.9	4.8	4.5	***	4.2	8.1	3.8	3.9	***	4.0
07-06-78	13.2	***	***	***	5.1	9.4	***	***	***	4.9
07-07-78	***	***	***	***	***	***	***	***	***	***
07-08-78	***	***	***	***	***	***	***	***	***	***
07-09-78	9.5	***	***	***	4.7	8.0	***	***	***	4.6
07-10-78	8.0	2.8	2.4	***	3.8	6.6	2.4	1.9	***	3.4
07-11-78	8.2	***	***	***	3.2	6.2	***	***	***	3.2

T-P---ACID-HYDROLYZABLE PHOSPHATE
O-P---ORTHOPHOSPHATE
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	T-P,mg/l					O-P,mg/l				
	I	A	N	F	E	I	A	N	F	E
07-12-78	9.2	3.8	4.2	***	3.4	6.9	3.8	3.6	***	0.2
07-13-78	10.7	***	***	***	3.7	8.3	***	***	***	3.7
07-14-78	***	***	***	***	***	***	***	***	***	***
07-15-78	***	***	***	***	***	***	***	***	***	***
07-16-78	10.6	***	***	***	4.3	9.2	***	***	***	4.2
07-17-78	10.2	6.8	6.3	***	5.1	9.1	6.2	5.9	***	5.0
07-18-78	25.5	***	***	***	5.2	22.9	***	***	***	5.2
07-19-78	27.4	5.9	5.7	***	6.2	26.3	4.9	5.2	***	4.0
07-20-78	12.3	***	***	***	4.1	9.8	***	***	***	***
07-21-78	***	***	***	***	***	***	***	***	***	***
07-22-78	***	***	***	***	***	***	***	***	***	***
07-23-78	6.5	***	***	***	3.6	4.2	***	***	***	3.5
07-24-78	8.4	2.6	4.2	***	2.8	6.2	2.2	3.5	***	2.7
07-25-78	7.8	***	***	***	3.3	5.9	***	***	***	3.2
07-26-78	9.5	4.2	3.9	***	3.1	6.9	3.3	3.2	***	3.1
07-27-78	8.3	***	***	***	2.9	6.5	***	***	***	2.8
07-28-78	***	***	***	***	***	***	***	***	***	***
07-29-78	***	***	***	***	***	***	***	***	***	***
07-30-78	11.0	***	***	***	3.6	7.7	***	***	***	3.5
07-31-78	7.7	0.8	2.0	***	1.0	5.5	0.6	1.6	***	1.9
08-01-78	7.2	***	***	***	1.8	4.9	***	***	***	1.6
08-02-78	8.3	2.0	2.4	***	1.8	5.9	1.4	2.0	***	1.6

T-P---ACID-HYDROLYZABLE PHOSPHATE
O-P---ORTHOPHOSPHATE
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	T-P,mg/l					O-P,mg/l				
	(I	A	N	F	E)	(I	A	N	F	E)
08-03-78	9.3	***	***	***	2.3	7.0	***	***	***	2.1
08-04-78	***	***	***	***	***	***	***	***	***	***
08-05-78	***	***	***	***	***	***	***	***	***	***
08-06-78	8.5	***	***	***	1.8	6.0	***	***	***	1.6
08-07-78	7.9	1.9	1.6	***	1.4	5.8	1.3	1.0	***	1.0
08-08-78	9.5	***	***	***	1.4	6.6	***	***	***	1.2
08-09-78	7.1	1.8	2.0	***	1.3	5.1	1.2	1.2	***	1.1
08-10-78	8.1	***	***	***	2.0	4.9	***	***	***	1.9
08-11-78	***	***	***	***	***	***	***	***	***	***
08-12-78	***	***	***	***	***	***	***	***	***	***
08-13-78	7.1	***	***	***	1.4	6.6	***	***	***	1.4
08-14-78	8.5	0.8	1.0	***	1.2	7.1	0.6	0.6	***	1.1
08-15-78	10.4	***	***	***	0.9	9.0	***	***	***	0.9
08-16-78	9.6	0.7	1.5	***	1.4	7.8	0.4	1.2	***	1.4
08-17-78	8.0	***	***	***	1.4	6.5	***	***	***	1.2
08-18-78	***	***	***	***	***	***	***	***	***	***
08-19-78	***	***	***	***	***	***	***	***	***	***
08-20-78	9.7	***	***	***	1.4	7.9	***	***	***	1.3
08-21-78	11.2	2.0	2.0	***	2.2	9.1	1.6	1.9	***	2.0
08-22-78	10.9	***	***	***	2.2	8.2	***	***	***	2.0
08-23-78	11.0	1.7	2.4	***	2.4	8.7	1.3	1.6	***	2.2
08-24-78	6.5	***	***	***	2.1	5.2	***	***	***	1.9

T-P---ACID-HYDROLYZABLE PHOSPHATE
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F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	T-P,mg/l					O-P,mg/l				
	I	A	N	F	E	I	A	N	F	E
08-25-78	***	***	***	***	***	***	***	***	***	***
08-26-78	***	***	***	***	***	***	***	***	***	***
08-27-78	10.6	***	***	***	1.8	9.2	***	***	***	1.6
08-28-78	12.8	1.4	1.7	***	2.2	10.9	1.1	1.5	***	2.0
08-29-78	11.4	***	***	***	3.3	4.9	***	***	***	3.0
08-30-78	10.3	2.1	2.3	***	6.9	9.9	1.2	1.8	***	2.1
08-31-78	6.9	***	***	***	2.8	6.5	***	***	***	2.7
09-01-78	***	***	***	***	***	***	***	***	***	***
09-02-78	***	***	***	***	***	***	***	***	***	***
09-03-78	11.3	***	***	***	1.8	10.0	***	***	***	1.6
09-04-78	9.1	1.8	3.2	***	1.6	2.1	1.3	3.0	***	1.4
09-05-78	13.3	***	***	***	3.6	12.5	***	***	***	3.1
09-06-78	10.5	1.0	1.6	2.0	2.5	9.2	0.7	1.0	1.3	2.2
09-07-78	9.1	0.8	2.7	2.2	1.8	6.1	0.7	2.3	2.1	1.6
09-08-78	***	***	***	***	***	***	***	***	***	***
09-09-78	***	***	***	***	***	***	***	***	***	***
09-10-78	13.1	***	***	***	2.0	11.3	***	***	***	1.9
09-11-78	10.7	0.9	1.3	1.4	1.2	9.2	0.9	1.2	1.0	1.1
09-12-78	9.8	***	***	***	1.4	10.0	***	***	***	1.2
09-13-78	10.2	0.5	1.1	0.6	1.0	10.0	0.5	1.1	0.5	0.9
09-14-78	10.5	***	***	***	1.0	10.8	***	***	***	0.8
09-15-78	***	***	***	***	***	***	***	***	***	***

T-P---ACID-HYDROLYZABLE PHOSPHATE
O-P---ORTHOPHOSPHATE
I-----PLANT INFLUENT
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F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	T-P,mg/l					O-P,mg/l				
	I	A	N	F	E	I	A	N	F	E
09-16-78	***	***	***	***	***	***	***	***	***	***
09-17-78	11.7	***	***	***	2.5	11.4	***	***	***	2.5
09-18-78	10.6	0.5	0.7	0.4	1.0	10.6	0.5	0.6	0.4	0.9
09-19-78	13.4	***	***	***	1.6	13.6	***	***	***	0.9
09-20-78	13.3	3.0	3.6	3.1	2.9	13.8	3.0	3.1	3.2	3.1
09-21-78	11.5	***	***	***	2.2	11.6	***	***	***	2.1
09-22-78	***	***	***	***	***	***	***	***	***	***
09-23-78	***	***	***	***	***	***	***	***	***	***
09-24-78	9.4	***	***	***	1.4	9.0	***	***	***	1.4
09-25-78	9.2	1.0	1.3	0.7	0.9	8.8	0.9	1.2	0.7	0.7
09-26-78	8.4	***	***	***	1.6	8.4	***	***	***	1.5
09-27-78	13.5	2.3	2.7	2.5	1.5	13.4	<0.1	2.7	2.5	1.6
09-28-78	14.6	***	***	***	1.6	13.9	***	***	***	1.8
09-29-78	***	***	***	***	***	***	***	***	***	***
09-30-78	***	***	***	***	***	***	***	***	***	***
10-01-78	11.0	***	***	***	1.3	10.1	***	***	***	1.1
10-02-78	17.5	1.3	1.8	1.0	1.1	13.5	1.4	2.0	1.0	1.1
10-03-78	***	***	***	***	2.7	***	***	***	***	2.4
10-04-78	79.0	1.3	2.3	1.4	3.8	73.1	1.2	2.1	1.4	3.4
10-05-78	13.4	***	***	***	1.3	13.4	***	***	***	1.2
10-06-78	***	***	***	***	***	***	***	***	***	***
10-07-78	***	***	***	***	***	***	***	***	***	***

T-P---ACID-HYDROLYZABLE PHOSPHATE
O-P---ORTHOPHOSPHATE
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	T-P,mg/l					O-P,mg/l				
	I	A	N	F	E	I	A	N	F	E
10-08-78	54.6	***	***	***	4.0	53.8	***	***	***	3.8
10-09-78	17.8	3.0	2.3	1.4	2.9	17.8	3.0	2.3	1.4	2.6
10-10-78	14.2	***	***	***	1.7	13.9	***	***	***	1.6
10-11-78	13.9	1.3	2.4	1.3	3.0	13.7	1.3	2.2	1.3	2.6
10-12-78	12.7	***	***	***	1.9	12.7	***	***	***	1.7
10-13-78	***	***	***	***	***	***	***	***	***	***
10-14-78	***	***	***	***	***	***	***	***	***	***
10-15-78	11.0	***	***	***	1.1	10.4	***	***	***	1.1
10-16-78	9.8	4.7	3.9	4.2	4.7	8.9	3.9	3.9	3.8	1.4
10-17-78	11.2	***	***	***	3.3	10.8	***	***	***	2.4
10-18-78	11.5	3.3	5.8	2.3	2.9	11.5	3.3	5.8	2.3	2.9
10-19-78	10.5	***	***	***	4.5	9.4	***	***	***	2.9
10-20-78	***	***	***	***	***	***	***	***	***	***
10-21-78	***	***	***	***	***	***	***	***	***	***
10-22-78	12.3	***	***	***	4.5	10.9	***	***	***	2.7
10-23-78	11.8	3.3	3.6	3.7	3.0	10.5	3.3	3.6	3.5	2.8
10-24-78	13.9	***	***	***	4.6	12.9	***	***	***	4.0
10-25-78	15.5	***	***	***	3.0	11.7	***	***	***	2.8
10-26-78	15.7	1.4	1.5	1.3	4.0	14.0	1.0	1.4	1.3	3.5
10-27-78	8.6	1.1	1.4	1.1	1.6	6.8	0.7	1.0	0.9	1.4
10-28-78	10.8	1.1	1.7	1.7	1.9	8.3	0.8	1.2	1.3	1.7
10-29-78	10.9	1.9	1.9	2.0	2.2	8.7	1.3	1.6	1.7	1.8

T-P---ACID-HYDROLYZABLE PHOSPHATE
O-P---ORTHOPHOSPHATE
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	T-P,mg/l					O-P,mg/l				
	I	A	N	F	E	I	A	N	F	E
10-30-78	12.0	2.1	2.2	2.3	3.1	9.2	1.5	1.9	1.8	2.8
10-31-78	10.4	2.2	2.7	2.2	2.7	7.3	1.4	2.0	1.8	2.4
11-01-78	9.9	2.4	2.8	2.4	3.5	7.1	1.5	2.2	2.1	2.8
11-02-78	11.2	1.7	2.2	2.0	2.9	8.1	1.0	1.7	1.7	2.4
11-03-78	11.3	2.3	2.4	2.1	2.4	7.9	1.6	1.9	1.8	2.0
11-04-78	11.0	3.4	3.7	4.1	2.6	7.8	2.5	3.0	3.3	2.4
11-05-78	10.8	0.6	0.8	0.8	2.5	8.4	0.4	0.6	0.6	2.2
11-06-78	13.0	0.5	0.7	0.5	1.4	8.3	0.4	0.5	0.4	1.3

T-P---ACID-HYDROLYZABLE PHOSPHATE
O-P---ORTHOPHOSPHATE
I-----PLANT INFLUENT
A-----CLARIFIER EFFLUENT
N-----NITRIFICATION TOWER EFFLUENT
F-----MIXED MEDIA FILTER EFFLUENT
E-----PLANT EFFLUENT
***---UNDEFINED DATA

DATE	TURB.,JTU		pH			TEMP.,°C		LIME,mg/l
	C	E	I	C	E	I	E	
06-20-78	***	25	7.6	***	7.9	21	21	***
06-21-78	***	20	7.6	***	7.2	20	21	***
06-22-78	***	***	7.5	***	6.9	20	19	***
06-23-78	***	34	7.5	***	7.0	20	21	***
06-24-78	96	36	7.7	***	7.0	19	21	***
06-25-78	***	30	7.7	***	6.8	19	20	626
06-26-78	***	18	7.7	***	7.0	26	23	620
06-27-78	***	18	7.7	***	6.9	22	24	491
06-28-78	***	23	7.8	***	7.0	21	23	469
06-29-78	***	18	7.7	***	6.9	21	23	629
06-30-78	***	19	7.7	***	6.9	21	23	710
07-01-78	78	10	8.1	***	***	22	22	736
07-02-78	***	22	7.5	***	6.9	20	22	567
07-03-78	***	30	7.5	***	7.1	22	23	377
07-04-78	***	30	7.8	***	7.4	20	24	325
07-05-78	***	40	7.6	***	7.2	21	21	279
07-06-78	130	38	7.6	***	7.0	22	22	342
07-07-78	200	25	7.7	10.2	7.0	22	23	357
07-08-78	100	35	7.7	11.3	7.0	21	23	420
07-09-78	165	27	7.7	11.0	7.0	21	22	410
07-10-78	89	32	7.2	11.3	6.6	22	24	***
07-11-78	159	31	7.3	11.0	6.4	21	21	482

TURB-TURBIDITY IN JACKSON TURBIDITY UNITS
pH---IN STANDARD UNITS
I----PLANT INFLUENT
C----CLARIFIER EFFLUENT (BEFORE NEUTRALIZATION)
E----PLANT EFFLUENT
***--UNDEFINED DATA

DATE	TURB.,JTU		pH			TEMP., °C		LIME,mg/l
	C	E	I	C	E	I	E	
07-12-78	191	20	7.6	10.9	6.7	21	21	400
07-13-78	271	25	7.6	10.6	6.8	20	22	398
07-14-78	226	25	7.6	10.6	6.9	21	22	348
07-15-78	219	21	7.6	9.9	6.6	22	21	341
07-16-78	374	32	7.7	9.7	6.8	22	23	318
07-17-78	260	31	7.7	10.1	6.9	21	22	370
07-18-78	119	29	7.5	11.1	6.7	22	23	365
07-19-78	232	21	7.5	10.0	6.7	21	22	344
07-20-78	301	28	7.6	9.8	6.7	22	25	305
07-21-78	59	28	9.4	***	6.7	25	27	***
07-22-78	82	65	7.4	11.5	6.4	23	26	***
07-23-78	94	76	7.1	11.6	***	25	26	***
07-24-78	180	20	7.6	10.7	6.8	22	24	418
07-25-78	240	9	7.7	10.8	7.1	22	24	367
07-26-78	380	21	7.6	10.4	6.7	22	23	396
07-27-78	277	22	7.9	11.1	7.0	21	22	485
07-28-78	58	17	7.6	11.6	6.8	22	24	540
07-29-78	375	30	7.4	11.5	6.8	22	22	510
07-30-78	156	32	7.4	11.1	6.7	22	23	662
07-31-78	46	15	7.5	11.6	6.7	21	21	619
08-01-78	49	14	7.5	11.9	7.0	22	22	576
08-02-78	72	4	7.6	11.6	6.9	22	24	510

TURB-TURBIDITY IN JACKSON TURBIDITY UNITS
pH---IN STANDARD UNITS
I----PLANT INFLUENT
C----CLARIFIER EFFLUENT (BEFORE NEUTRALIZATION)
E----PLANT EFFLUENT
***--UNDEFINED DATA

DATE	TUBR.,JTU		pH			TEMP.,°C		LIME,mg/l
	C	E	I	C	E	I	E	
08-03-78	168	8	7.4	10.0	6.9	22	23	237
08-04-78	82	8	7.6	11.6	6.8	21	21	471
08-05-78	95	10	7.7	11.5	6.9	22	23	543
08-06-78	6	9	7.5	11.9	7.9	22	22	557
08-07-78	2	25	7.6	11.8	7.5	23	23	540
08-08-78	39	39	7.5	12.0	6.9	23	24	553
08-09-78	29	21	7.7	11.6	7.1	23	24	624
08-10-78	81	38	8.1	11.9	7.6	23	24	690
08-11-78	66	29	7.4	11.8	7.6	22	23	661
08-12-78	32	14	7.5	11.5	7.4	21	22	510
08-13-78	34	20	7.6	11.7	7.2	23	23	541
08-14-78	34	7	7.6	11.9	7.1	23	23	576
08-15-78	48	8	7.7	12.0	7.3	22	23	539
08-16-78	22	19	8.1	12.0	7.9	23	24	592
08-17-78	51	8	7.8	11.8	7.8	23	24	644
08-18-78	33	9	7.6	11.9	7.7	22	22	704
08-19-78	12	2	7.7	11.9	7.2	24	25	575
08-20-78	51	6	7.5	11.7	7.4	23	24	536
08-21-78	77	30	7.5	11.7	7.1	23	23	431
08-22-78	59	18	7.5	11.7	7.3	23	24	513
08-23-78	73	7	7.6	11.7	7.1	22	23	509
08-24-78	48	21	7.1	11.7	7.1	24	24	***

TURB-TURBIDITY IN JACKSON TURBIDITY UNITS
pH---IN STANDARD UNITS
I----PLANT INFLUENT
C----CLARIFIER EFFLUENT (BEFORE NEUTRALIZATION)
E----PLANT EFFLUENT
***--UNDEFINED DATA

DATE	TURB.,JTU		pH			TEMP., °C		LIME,mg/l
	C	E	I	C	E	I	E	
08-25-78	81	12	7.7	11.8	7.4	23	24	491
08-26-78	28	5	7.8	11.8	7.1	22	23	523
08-27-78	39	10	8.0	11.9	7.3	21	23	488
08-28-78	62	8	7.5	11.8	7.4	24	23	500
08-29-78	129	16	7.8	10.7	7.3	22	22	276
08-30-78	62	16	7.6	11.8	7.3	22	23	497
08-31-78	29	7	7.4	11.9	7.0	20	20	464
09-01-78	19	7	7.5	11.8	7.1	21	22	522
09-02-78	49	5	7.7	11.5	7.3	23	23	490
09-03-78	81	15	7.7	9.7	7.8	23	24	***
09-04-78	131	7	7.6	11.4	7.3	22	23	523
09-05-78	58	8	7.6	11.7	7.1	22	22	498
09-06-78	50	6	9.2	11.7	7.3	25	26	***
09-07-78	60	7	9.0	11.7	7.4	24	25	***
09-08-78	49	7	7.7	11.6	7.5	22	22	515
09-09-78	36	12	7.4	11.6	7.3	24	26	500
09-10-78	30	8	7.8	11.8	7.6	22	23	557
09-11-78	11	5	7.6	11.5	7.3	24	25	456
09-12-78	33	11	7.6	11.7	7.4	23	24	557
09-13-78	15	8	7.6	11.6	7.3	23	24	545
09-14-78	16	5	8.1	11.7	6.8	23	23	497
09-15-78	15	2	7.4	11.3	7.1	24	25	493

TURB-TURBIDITY IN JACKSON TURBIDITY UNITS
pH---IN STANDARD UNITS
I----PLANT INFLUENT
C----CLARIFIER EFFLUENT (BEFORE NEURTALIZATION)
E----PLANT EFFLUENT
***--UNDEFINED DATA

DATE	TURB.,JTU		pH			TEMP.,°C		LIME,mg/l
	C	E	I	C	E	I	E	
09-16-78	159	29	7.4	7.3	7.0	23	23	***
09-17-78	19	13	7.1	11.2	7.0	23	24	503
09-18-78	25	10	7.2	11.3	7.0	23	24	513
09-19-78	50	9	7.1	11.5	6.9	24	24	353
09-20-78	148	7	7.6	11.0	6.9	23	24	574
09-21-78	50	15	7.5	11.5	6.9	24	26	506
09-22-78	39	5	7.5	11.4	6.9	22	22	513
09-23-78	61	11	7.3	11.2	6.3	19	18	434
09-24-78	19	9	6.7	11.5	7.0	21	21	***
09-25-78	28	18	7.2	11.5	7.3	20	20	***
09-26-78	39	24	7.8	11.7	7.8	20	19	584
09-27-78	45	25	7.3	11.6	7.9	20	19	496
09-28-78	42	13	7.5	11.5	7.4	21	20	515
09-29-78	44	30	7.6	11.7	7.8	19	18	573
09-30-78	30	22	7.7	11.6	7.9	19	18	619
10-01-78	28	15	7.7	11.8	7.9	20	19	579
10-02-78	48	32	7.6	11.6	8.8	20	18	579
10-03-78	78	22	8.0	11.6	7.6	19	18	532
10-04-78	31	50	7.4	11.8	7.7	20	20	***
10-05-78	20	30	7.5	11.8	7.6	20	19	***
10-06-78	50	29	7.6	11.6	8.4	19	18	447
10-07-78	31	29	7.7	11.4	7.5	18	17	474

TURB-TURBIDITY IN JACKSON TURBIDITY UNITS
pH---IN STANDARD UNITS
I----PLANT INFLUENT
C----CLARIFIER EFFLUENT (BEFORE NEUTRALIZATION)
E----PLANT EFFLUENT
***--UNDEFINED DATA

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DROPPED HEAD; BEGIN SECTIONS HERE
TYPING GUIDE SHEET
CENTER OF PAGE
3/8"
6 1/2"
EPA-287 (Clin.) (4-76)
PAGE NUMBER
77
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
TOP OF IMAGE AREA

DATE	TURB.,JTU		pH			TEMP.,°C		LIME,mg/l
	C	E	I	C	E	I	E	
10-08-78	91	66	7.9	11.5	7.5	18	17	479
10-09-78	70	29	7.5	11.6	8.5	20	19	462
10-10-78	58	39	7.5	11.4	8.8	19	18	441
10-11-78	36	28	7.3	11.7	7.8	19	18	418
10-12-78	89	7	7.6	11.4	7.3	20	20	420
10-13-78	39	5	7.3	11.6	7.7	18	17	538
10-14-78	96	299	7.8	11.6	7.8	16	15	***
10-15-78	72	70	7.6	11.4	7.7	16	15	465
10-16-78	68	40	7.4	11.4	8.9	17	17	441
10-17-78	66	50	7.5	11.5	8.0	16	15	476
10-18-78	74	42	7.6	11.5	8.0	17	16	477
10-19-78	40	31	7.6	11.8	7.9	18	19	511
10-20-78	50	20	7.2	11.8	7.6	18	17	603
10-21-78	61	9	7.6	11.8	7.6	18	17	585
10-22-78	42	12	7.7	11.7	7.8	17	17	577
10-23-78	60	16	8.1	11.9	7.4	19	20	532
10-24-78	72	22	7.1	11.5	7.5	18	18	558
10-25-78	73	15	7.3	11.5	7.1	15	14	465
10-26-78	62	19	7.6	11.8	7.1	19	19	494
10-27-78	39	6	7.5	11.8	7.6	18	18	527
10-28-78	35	5	7.4	11.9	7.7	19	19	430
10-29-78	60	8	7.3	11.7	7.6	20	18	459

TURB-TURBIDITY IN JACKSON TURBIDITY UNITS
pH---IN STANDARD UNITS
I----PLANT INFLUENT
C----CLARIFIER EFFLUENT (BEFORE NEUTRALIZATION)
E----PLANT EFFLUENT
***--UNDEFINED DATA

BEGIN FIRST LINE OF TEXT HERE
TYPING GUIDE SHEET
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD; BEGIN SECTIONS HERE

DATE	(TURB.,JTU) C	E	(I	(pH C	E	) (TEMP.,°C I	E	) (LIME,mg/l)
10-30-78	70	29	7.5	11.6	7.6	20	20	507
10-31-78	52	20	7.4	11.6	7.6	18	18	499
11-01-78	76	23	7.5	11.7	7.5	19	19	512
11-02-78	50	22	7.1	11.3	7.2	20	19	509
11-03-78	60	7	7.4	11.8	7.4	19	19	525
11-04-78	89	13	7.6	11.6	7.8	18	17	496
11-05-78	38	18	7.6	11.6	7.8	19	18	483
11-06-78	28	19	7.6	11.7	7.6	19	19	471

TURB-TURBIDITY IN JACKSON TURBIDITY UNITS
PH---IN STANDARD UNITS
I----PLANT INFLUENT
C----CLARIFIER EFFLUENT (BEFORE NEUTRALIZATION)
E----PLANT EFFLUENT
***--UNDEFINED DATA

6-1/2"
BEGIN LAST LINE OF TEXT
3/8"
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS

EPA-287 (Cin.)
(4-76)